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14. ABSTRACT

The report begins by providing the reader with an historical perspective of the munitions requirements process derived from review of Government-sponsored reports and critiques spanning more than a decade. This is followed by a description of the process as it is currently articulated in DoD and USMC guidance. Next, the report documents the munitions requirements development process as it is currently executed in the Marine Corps and proceeds to identify issues, concerns and problems with that execution. The US Army's munitions requirements development process is then described to establish areas of potential utility for improving the Marine Corps approach. Subsequently, the report proposes solutions for addressing all issues, concerns and problems identified in the Marine Corps process and execution. The report then examines the validity of the CPFs generated by the WRMR model and assesses their utility to operational planners. Finally, the report presents a vision that lays out an analytical framework, organizational roles and responsibilities and a timeline for each step of a potential future end-to-end munitions requirements development process that aligns with DoD guidance and generates transparent, credible estimates that result in a timely, analytically sound Total Munitions

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ABSTRACT

The objectives of the USMC Ground Ammunition Requirements (GAR) Study were to describe, evaluate and improve the way the Marine Corps determines its ground ammunition requirements. In particular the study was to address: 1) the estimation of war reserve munitions requirements; 2) the development and use of combat planning factors; and 3) the estimation of the training ammunition requirements.

The report is structured to comprehensively address all the tasks assigned to the study. It is also designed to serve as an easy-to-follow tutorial on the munitions requirements development process that can quickly educate future incoming Marine Corps personnel with responsibilities in this area.

The report begins by providing the reader with an historical perspective of the munitions requirements process derived from review of Government-sponsored reports and critiques spanning more than a decade. This is followed by a description of the process as it is currently articulated in DoD and USMC guidance. Next, the report documents the munitions requirements development process as it is currently executed in the Marine Corps and proceeds to identify issues, concerns and problems with that execution. The US Army's munitions requirements development process is then described to establish areas of potential utility for improving the Marine Corps approach. Subsequently, the report proposes solutions for addressing all issues, concerns and problems identified in the Marine Corps process and execution. The report then examines the validity of the CPFs generated by the WRMR model and assesses their utility to operational planners. Finally, the report presents a vision that lays out an analytical framework, organizational roles and responsibilities and a timeline for each step of a potential future end-to-end munitions requirements development process that aligns with DoD guidance and generates transparent, credible estimates that result in a timely, analytically sound Total Munitions Requirement (TMR).

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1 Executive Summary

1.1 Objectives and Scope

The objectives of the USMC Ground Ammunition Requirements (GAR) Study were to describe, evaluate and improve the way the Marine Corps determines its ground ammunition requirements. In particular the study was to address: 1) the estimation of war reserve munitions requirements; 2) the development and use of combat planning factors; and 3) the estimation of the training ammunition requirements.

The study was chartered to review the Marine Corps munitions requirements process (MRP). The focus was to be on the Marine Corps ground ammunitions requirements process, development, and generation. An examination of Marine Corps aviation ammunition requirements was outside the scope of the study as these requirements are developed through the Navy's Non-Nuclear Ordnance Requirements (NNOR) process.

1.2 Methodology

The GAR Study Team organized its approach to the objectives according to the logic flow illustrated in Figure 1-1 below.

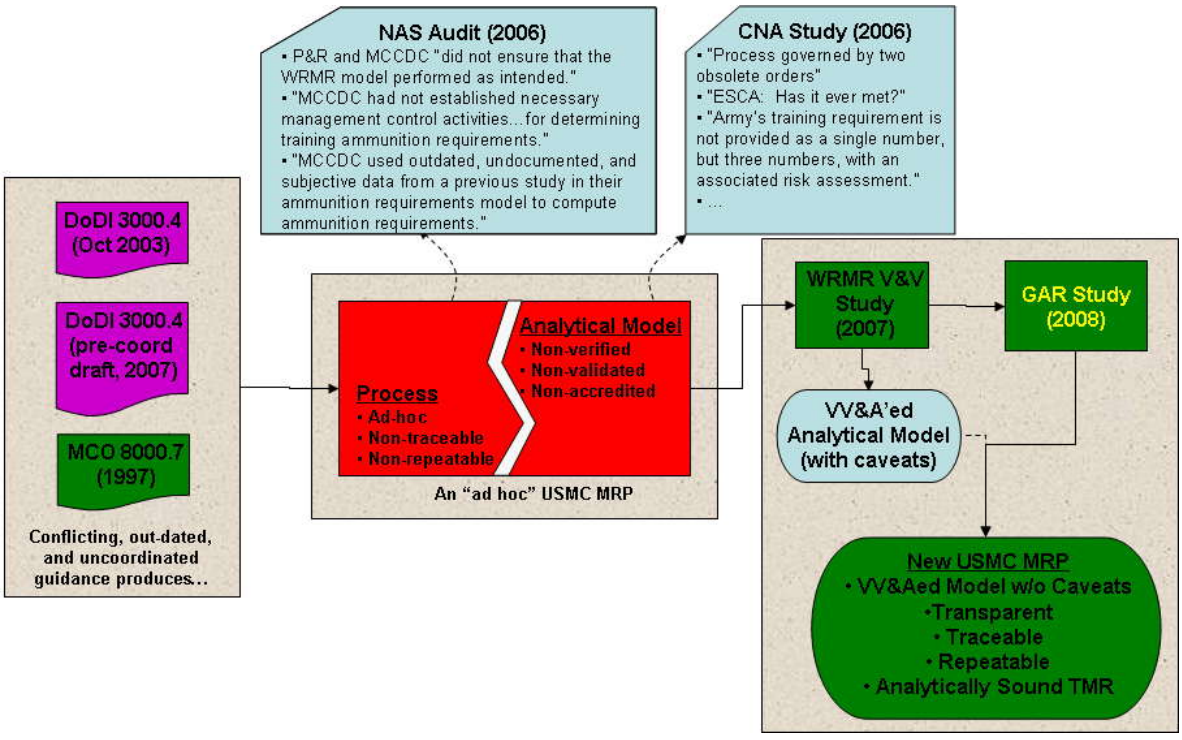

Figure 1-1: GAR Study Logic Flow

The GAR Study Team's initial effort focused on a review of Department of Defense (DoD) and Marine Corps orders and guidance which define the MRP, as well as the 2006 Naval Audit Service Report entitled *Models Used by the Marine Corps to Determine Requirements and Budget for Ammunition* which indicated MCCDC had not performed verification and validation (V&V) of the WRMR model it uses to determine requirements, and failed to establish the necessary management and control activities to develop an accurate and reliable methodology for computing training ammunition requirements.

Building on the work of the WRMR Model V&V Study Team, the GAR Study Team delved further into the workings of the WRMR model and the data within it to identify issues, concerns and problems. Where any such instances were identified, a comparison was made with methodologies used by the US Army in its munitions requirements process to determine if integration of these methods would improve the Marine Corps MRP. The GAR Study Team also interviewed and maintained e-mail correspondence with DoD, COCOM, and Joint Staff representatives to analyze and identify issues with products developed by these organizations, which contribute to the Marine Corps MRP. The GAR Study Team used interviews with USMC operational planners, ammunition officers and combat service support school instructors to determine the validity of the WRMR-model generated CPFs and assess their utility to these personnel.

To assist any future Ammunition Requirements Officer (ARO) tasked with developing the Marine Corps' Total Munitions Requirement (TMR), the GAR Study Team produced a vision of a future USMC MRP that lays out an analytical framework, organizational roles and responsibilities and a timeline for each task in an end-to-end cycle that aligns with DoD guidance, provides traceability of source data, and generates a transparent, analytically sound submission.

1.3 Study Impact on the POM-10 MRP

One of the major factors for consideration included in the RFP was that the study would attempt to produce preliminary results in order to provide insights to the POM-10 MRP. Consequently, the work-flow of this study was developed such that the initial products would be able to influence and improve the POM-10 TMR. During the first study interim progress review (IPR) in December 2007, the GAR Study Team proposed the following five recommendations with the potential to affect ground munitions requirements estimates in the POM-10 cycle:

- **Employ historical usage rates to estimate the requirement for obscuration and illumination munitions.** Noting that the WRMR Model V&V Study indicated that the obscuration and illumination expenditures generated by the WRMR model were excessive, the GAR Study Team provided historical usage rates for these munitions relative to anti-personnel/anti-material (AP/AM) expenditures and proposed that MCCDC employ this as an interim methodology for determining requirements for POM-10. This recommendation was implemented. Table 1-1 below illustrates the changes in the estimates for FY10 between the POM-08 and POM-10 MRPs:

Munition	DODIC	POM-08 FY10 Requirement	POM-10 FY10 Requirement	Delta, in %	Delta, in $
60mm Illum. M721	B647	210,108	43,980	-79%	($116,768,049)
60mm Smoke M722	B646	169,587	16,179	-90%	($166,093,308)
81mm Illum M816 + M772	C484, C871	116,383	109,012	-6.3%	($7,728,024)
81mm Smoke M853A1	C870	17,289	88,221	410.3%	$40,669,572
155mm Illum. M485A2	D505	17,740	23,915	34.8%	$8,882,861
155mm Smoke M825	D528	47,592	15,974	-66.4%	($13,668,778)

Table 1-1: POM-08 vs. POM-10 Obscuration & Illumination Requirements Comparison[1]

As the table shows, the new methodology led to decreases for some munitions and to increases for other types, collectively accounting for a reduction of more than $250 million in the final TMR. Further, the methodology and data used for the POM-10 TMR is traceable and will support comparative analysis across POM cycles.

- **Calculate Phase IV expenditures using historical OIF/OEF expenditure rates over the past three years.** This recommendation was implemented. The Phase IV requirement was not calculated within the WRMR model and incorporated into the combat requirement. Instead, data on actual OIF/OEF expenditures were used to develop an additional current operations requirement. This added more than 11.3 million rounds costing in excess of $40 million to the CO/FPR in the POM-10 TMR.

- **Include two training requirements in the TMR.** To more accurately reflect the impact of deployments and other conditions that constrain training opportunities,

[1] Reflects per-round cost associated with FY10 in approved POM-10 TMR worksheet. B647=$702.88. B646=$1,082.69. C484=$662.71. C871=$753.48. C870=$573.36. D505=1,438.52. D528=$432.31.

the GAR Study Team suggested using a baseline, peace-time requirement, as well as a "critical" requirement where the baseline is modified by the historical percentage of training allowance actually expended. This recommendation was not implemented. Some insights regarding the impact this would have had on the TMR can be found in section 7.2.4.1 of this document, Historical Analysis of Training Munition Expenditures and Relationship to the Critical Requirement.

- **Exclude the Peacetime Pipeline (PPL) from the TMR.** This recommendation was not implemented. The POM-10 TMR included costs of nearly $300 million for munitions in the PPL. The PPL is a way of maintaining an account for training-unique munitions that have been purchased but not yet delivered to Marine Corps units. Accounting for these munitions provides a risk mitigation strategy to alleviate potential shortfalls that could result from the geographic distribution of training munitions and/or potential interruptions in the supply chain. While the need to account for this category of munitions has been recognized in USMC guidance and is advocated by MARCORSYSCOM, accounting for the cost of this pipeline in the TMR remains contentious as it is not specifically included in the DoD guidance as a legitimate element of the TMR calculation. Subsequent to making this initial recommendation, the GAR Study Team reviewed Marine Corps Order (MCO) 8000.7 and other USMC documentation and determined that the language could justify including the PPL as an element of the TMR. A detailed discussion of the PPL and how it might be best accounted for can be found in sections 4.2.4.3, 5.2.4.3, and 7.2.4.3 of this document.

- **Change the WRMR model to not account for enemy weapon systems being repaired and returned to the target set over the course of a campaign.** Given that the effects of equipment repair and return capabilities are already incorporated into the Phased-threat Distributions (PTDs) produced by the COCOMs and J-8 to support the development of the TMR, accounting for the effects of these functions in the WRMR model is double-counting that falsely inflates the target set and resulting munitions expenditures needed to destroy it. This recommendation was approved by MCCDC and the WRMR model was changed for POM-10 to exclude the effects of repair and return of equipment to the battlefield. While this change in calculating the total campaign target set for ground munitions certainly brought about a corresponding reduction in the number of munitions expended, quantifying the actual reduction in terms of rounds or dollars is difficult absent WRMR model runs that enable a direct comparison of the repair/return and no repair/no return cases. The general ability of repair/return calculations to influence munitions requirements is discussed, however, in section 5.2.1.1 of this report.

In addition to generating these recommendations, the GAR Study Team reiterated the recommendation of the WRMR Model V&V Study Team that the TMR should not include estimates for munitions associated with maritime pre-positioning ships (MPS). These munitions are distributed to units for use in combat operations and as such are accounted for in the WRMR model's calculation of combat expenditures. Therefore, inclusion of a separate estimate for MPS munitions is a double-counting of the requirement. MCCDC

implemented the recommendation and did not include the MPS requirement in the POM-10 TMR, amounting to a reduction of nearly 118.5 million rounds valued at over $2.4 billion from the submission.

1.4 Recommendations

The GAR Study Team identified a number of issues, concerns and problems with the USMC MRP and recommended solutions to address them. The most important recommendations, as defined by the GAR Study Team, are detailed below and categorized by their relation to 1) the overall munitions requirements estimation process and 2) to the WRMR model itself.

Process Recommendations

Update MCO 8000.7 to institutionalize and document a formal process that assigns organizational roles and responsibilities that conform to evolving DoD guidance. The USMC MRP is currently, by necessity, an "ad-hoc" process. The current Marine Corps Order guiding the MRP (MCO 8000.7) dates to 1997 and is not aligned with the overarching guidance contained in either the signed 2003 DoD Instruction (DoDI) 3000.4, entitled *DoD Munitions Requirements Process (DoD MRP)*, that governed previous MRPs, a 2007 pre-coordination draft of DoDI 3000.4 which guided the POM-10 cycle and a subsequent version obtained by the GAR Study Team in April 2008. Absent updated and synchronized guidance, MCCDC has been forced to perform the MRP in a make-do, undocumented manner. While the US Army has no comparable order and the US Navy's guidance is also outdated, these Services, however, have a historically consistent, clearly defined and well-documented process in which each supporting organization understands its assigned responsibilities.

Develop an archive to maintain all data and documents associated with the MRP. Multiple DoD and Marine Corps instructions, orders and other documents have bearing on the MRP. As these evolve on differing timetables, staying abreast of changes and current guidance is challenging. Also, WRMR model methodological assumptions and data sources and changes are not well documented, preventing incoming AROs from fully understanding the history of the current input values and whether they are still appropriate for the development of the pending TMR. Furthermore, WRMR model data is not updated in an organized fashion as appropriate Marine Corps organizations have not been identified and formally tasked with providing this information. A web-based archive could be an effective, efficient means of maintaining all data and documents associated with the MRP, establishing model input assumptions and values, and tracking and explaining changes over time. This archive could also maintain, by functional area, all WRMR model input data, and facilitate access by a Marine Corps organization identified for each area and tasked with performing a periodic review of the data. (The GAR Study Team produced a functional prototype archive and provided it with the report.)

All inter-organizational requests for support or data should be made via a Marine Corps Action Tracking System (MCATS) tasker. The current MCCDC MRP business

practice relies upon e-mail to request assistance from supporting Marine Corps organizations during the MRP. Without formal tasking, these organizations may not properly or responsively support these requests with appropriate time and resources. Use of MCATS for MRP actions offers an at-hand, proven approach to address this issue.

Provide senior-level oversight across the MRP through a body similar to the US Army's Council of Colonels. Recent USMC TMR submissions have had a dollar value of more than $5 billion, a level of resources that clearly warrants close scrutiny by the Marine Corps leadership. MCO 8000.7 states that an Executive Steering Committee for Ammunition (ESCA) composed of flag officers is to provide oversight of the MRP, yet a 2006 study by the Center for Naval Analysis could find no evidence this body had ever met. The accuracy and credibility of the TMR will be improved by involving informed senior decision-makers, much as the Army does, throughout the process to validate both the input assumptions used to generate the TMR as well as to review interim results prior to submission of the final TMR.

Support the MCCDC ARO with civilian personnel to realize enduring benefits to the MRP. Unlike the US Army and Navy, the Marine Corps does not employ dedicated civilian personnel in long-term positions to support the MCCDC ARO in the MRP. With military personnel transitioning frequently, it is difficult for the Marine Corps MRP to realize the benefits that come from having personnel whose tenure is lengthy enough to provide continuity in the process across multiple MRP cycles, maintain the institutional knowledge that promotes consistency and coherence in the products, and sustain process improvements whose implementation will span several years.

Maintain active, physical participation with DoD, Service and other organizations in meetings that influence the POM. Under Version 6 of the proposed revision to DoDI 3000.4, an MRP Working Group was established. This organization comprises DoD, COCOM and Service representatives and holds monthly meetings or video teleconferences. MCCDC should continue to attend each of these meetings to advocate the resolution of outstanding Marine Corps issues with the MRP or supporting documents provided by DoD or the COCOMs, as well as to provide input to and understand the changes being introduced to the MRP during any further revision of DoDI 3000.4. Likewise, the MCCDC ARO or another appropriate Marine Corps representative should participate in the semi-annual Joint Technical Coordinating Group / Munitions Effectiveness (JTCG/ME) meetings to advocate the development of shooter/target pairings required to support the MRP but not provided in JMEM/Surface-To-Surface Weaponeering Effectiveness System (JWES). Active, physical participation in these meetings, as opposed to e-mail corresponsence or similar passive methods of participation, will improve the ARO's understanding of outstanding issues and increase the likelihood that Marine Corps recommendations are implemented.

Develop Combat Planning Factors (CPFs) specifically for urban / counter-insurgency operations. Currently, the WRMR model calculates CPFs only for major combat operations against a composite (armor-infantry mix) threat force. These CPFs fail to capture the unique weapon mix and utilization required to combat insurgent forces or

perform military operations on urban terrain. The WRMR model methodology should be expanded to develop CPFs that reflect how operations are conducted against asymmetrical threats and in congested environments.

WRMR Model Issues, Concerns and Problems

Expanding on the work performed by the WRMR Model V&V Study Team, the GAR Study Team proposed recommendations to address the workings of the WRMR model. Four of these recommendations follow.

Modify the WRMR model to accommodate a more fluid sequence of operational intensity during a given phase. The WRMR model algorithm distributes targets across one instance of high-intensity combat and one instance of low-intensity combat per phase. Real-world operations and COCOM OPLANs, however, often involve multiple instances of these intensity levels per phase, carried out by forces varying in size and mix according to the force flow. This argues for more flexibility in WRMR model target distribution.

Modify the WRMR model to calculate obscuration and illumination expenditures in a manner that more accurately portrays real-world expenditure rates for these munitions. The WRMR Model V&V Study Team found, and the GAR Study Team subsequently assessed, two flaws in the methodology currently used in the model to calculate smoke and illumination requirements. First, the requirement is defined as the daily number of smoke/illumination minutes required by infantry company by supporting system, a combination of knowledge areas that is difficult for a single SME to provide. An experienced commander of an infantry company should understand the number of minutes of smoke or illumination required during an average day of combat, but will not be as concerned about the distribution of these minutes to the supporting systems as this would be a factor that would vary with each engagement. Likewise, artillery commanders should understand their specific system capabilities with regard to providing smoke and illumination support, but would likely find it difficult to provide an expected level of support per infantry company while taking into account the other types of support systems in other units that may be available to the infantry unit. The second problem is that the requirement is disassociated from the number of supporting systems available. As the number of infantry companies increase, the requirement increases regardless of whether or not the supporting systems' sustained rate of fire can satisfy it. For the POM-10 TMR, the GAR Study Team suggested calculating smoke and illumination expenditure rates as a percentage of target-oriented munitions expenditures. The methodology, however, relies on historical expenditures and should be considered as only an interim solution. The GAR Study Team subsequently proposed an approach that rectifies the two major flaws found in the current implementation. This approach simplifies the SME knowledge required to develop supporting data, working from a single infantry company's requirement for daily smoke/illumination minutes, allowing the algorithm to determine the minutes to be provided by individual weapon system and automatically adjusting the results based on the number and type of weapon systems that are available to provide support to the infantry companies. Regardless of whether this approach is adopted, a new algorithm should be developed for the WRMR model that can be supported with available data and more

credibly accounts for the effects of changes in technology (i.e., night vision systems) and tactics on the use of obscuration and illumination rounds.

Modify the WRMR model to more accurately reflect the limited weapon use associated with rear-area security actions experienced in real-world operations. The WRMR model currently requires a SME to estimate a daily expenditure rate associated with rear-area security actions for every munition type in the non-ground combat element (non-GCE) forces. The problem with this calculation is that it does not accurately reflect how rear-area security operations occur, making it difficult for SMEs to provide accurate assessments of expenditures per weapon per day. Most rear-area security expenditures will be associated with base or convoy defense personnel. The quantity of weapons maintained in these forces is relatively small compared to the overall number of weapons in the rear area given that nearly all personnel, including those in administrative, logistics, and other support units, possess a weapon while in theater. Without accounting for some limits on who in the rear area will be involved in security actions, it is possible for the WRMR model to calculate rear-area expenditures for many munitions that exceed the quantity expended in front-line combat operations. Indeed, this is the case with current SME-supplied data in the model. The GAR Study Team proposed a methodology that relies on values for rear-area episodes per day and rounds per episode data that are obtainable from historical sources. The methodology accounts only for rounds expended by units engaged in these rear-area episodes and does not corrupt this data by trying to allocate expenditures across all weapons in the non-GCE.

Ensure the weapon systems and munitions accounted for in the WRMR model's self-defense module are exclusive to this category of expenditure. The WRMR model's rear-area formula determines small arms expenditures for non-GCE forces. Small arms expenditures for GCE forces are calculated with other target-oriented munitions. Thus, self-defense expenditures should be limited to only those weapon systems, such as sniper rifles, and associated munitions not explicitly modeled in these other modules to prevent double-counting of expenditures. The WRMR model should be modified to ensure the analyst can not mistakenly include weapon systems in the self-defense module that are accounted for in other functional areas of the model.

1.5 Vision for a Future MRP

The GAR Study Team compiled the recommendations to describe a future, end-to-end Marine Corps MRP that is informed by three separate yet related perspectives of the effort. The first view looks at the MRP from an **analytical perspective** to identify *what* needs to be done such that the MRP can proceed from a clear objective, common practices and transparent methods to produce credible, defensible estimates regardless of changes in the DoD guidance or models used. The second view looks at the MRP from an **organizational perspective** to identify *who* across a range of activities and functions should perform the specific roles and responsibilities that when combined will produce a coherent, comprehensive process. The third view reflects an **execution perspective** of the MRP, as in *when* and *how* things are to be done such that contributions and activities are aligned with

milestones that support a synchronized schedule of products and results.

Reflecting insights gained from viewing the MRP from these three perspectives, the GAR Study Team developed detailed descriptions of the following elements of a future MRP:

- an Analytical Framework that establishes the objectives of the effort, embraces a three-step process flow – collect data, perform analysis, validate results – that is standard for any quantitative assessment and ensures that all the essential elements of analysis (EEA) required for the TMR are addressed;

- an Organizational Framework that goes beyond first-order assignments to put an appropriate organization, skill set and/or position against a given role and establishes and publishes clear lines of authority and responsibility for actions and products associated with the MRP;

- a Communications Framework that embodies a web-based archive that can serve as an effective and efficient channel for sharing information and organizes the information for accurate access and reporting; and

- an Execution Framework in the form of a task-based timeline of a representative MRP cycle that maps the contributions of all participants, both internal and external to the Marine Corps, to the sequence of DoD and USMC activities and events that eventually culminates in the submission of the TMR.

2 Study Overview

2.1 Context and Background

At the command level, the stimulus for this study can be traced to a Naval Audit Service (NAS) report published in June 2006 and entitled *Models Used by the Marine Corps to Determine Requirements and Budget for Ammunition*. This audit was requested by the Deputy Commandant of the Marine Corps for Programs and Resources (DC P&R) to "verify whether the Marine Corps ammunitions [sic] requirement model was providing accurate and reliable information to make informed decisions on ammunition budget requirements." The audit focused on what was then called the Marine Corps Capabilities-Based Munitions Requirements Process (MCCBMRP) for ground ammunition and found:

- Input data used in the referenced model, the War Reserve Munitions Requirements (WRMR) model, to determine total munitions requirements was outdated, subjective, unsupported, and undocumented.
- DC P&R and the Marine Corps Combat Development Command (MCCDC) did not properly verify, validate, and accredit the WRMR model to ensure that the application of model results were appropriate for generating combat planning factors and ammunition requirements.
- MCCDC had not established the necessary management and control activities, such as policy and procedures, to develop an accurate and reliable methodology for computing training ammunition requirements.

In response to the findings of this audit, the Commandant of the Marine Corps directed a verification and validation (V&V) of the WRMR model be performed. The WRMR Model V&V Study was conducted by a team comprising the MCCDC / Logistics Integration Division (LID), MCCDC / Operations Analysis Division (OAD), and the WRMR model developer, Quantics, Inc. The study was completed in September 2007 and, based on its recommendations, the Senior Analyst for the Office of the Commanding General, MCCDC accredited the model for calculating target-oriented munitions requirements for the Program Objective Memorandum 10 (POM-10).

The WRMR Model V&V Study also identified a number of methodological limitations and issues that resource and time constraints associated with that effort precluded from being fully explored. Working from that knowledge, the MCCDC Ammunition Requirements Officer (ARO) advocated a follow-up effort with the immediate purpose of acting on the identified need to review, evaluate and provide recommendations for improving the WRMR model's methodologies for determining non-targeted munitions requirements. While addressing this specific area to support the POM-10 cycle was the primary impetus for this study, other issues identified in the WRMR V&V Study and growing concerns arising from changes in the overarching DoD guidance and MRP approach argued for expanding the focus to embrace a more comprehensive examination of the entire USMC

ground ammunition requirements estimation process.

In that regard, in October 2007, MCCDC OAD awarded Group W, Inc. a contract to conduct a Ground Ammunition Requirements (GAR) Study that would constitute a complete review of how the Marine Corps develops its munitions requirements. This effort was chartered to describe, evaluate, and identify improvements to how the Marine Corps estimates war reserve munitions requirements, calculates training ammunition requirements, and develops and uses combat planning factors. In addition, the effort was tasked to determine the relevance and potential utility of data generated as part of the Department of Defense Analytical Agenda (governed by DoD Directive 8260.1, *Data Collection, Development, and Management in Support of Strategic Analysis*) and its associated Analytical Baselines (governed by DoD Instruction 8260.2, *Implementation of Data Collection, Development, and Management for Strategic Analyses*).

2.2 Tasks, Scope and Methodology

This GAR Study comprises six tasks. This section describes the tasks and the approaches used by the GAR Study Team to execute them.

2.2.1 Task 1 – Literature Review

This task directed the performer to conduct a literature review of pertinent documents ensuring that all areas identified by the sponsor are covered. Further, the performer was directed to build on the foundation established during the WRMR Model V&V Study.

The approach involved identification and review of documents that met one or more of the following criteria:

- shape, influence or define the munitions requirements process both as conducted at the Department of Defense (DoD) level and as specifically performed by the Marine Corps;
- document the procedures and data flows used to generate elements of the DoD and USMC processes;
- describe the tools and methodologies currently used by the USMC to determine this requirement; and
- review or critique the charter and execution of the process.

A complete list of these documents can be found in Appendix B of this report.

2.2.2 Task 2 – Compare the USMC and Army Munitions Requirements Methodologies

This task directed the performer to compare the methods used by the U.S. Army and the Marine Corps to calculate ground ammunition requirements. The task posed the following key study questions:

- How do the ammunition requirements derived from the campaign simulation used by the Army differ from ammunition requirements derived from the WRMR model for both target-oriented and non-target-oriented munitions?
- How might the results from the two methods be integrated in the munitions requirements development process to better inform the POM-10 or future POM?
- Are the existing methods an adequate means for determining the current operations/forward presence and the strategic readiness requirements?

The approach built upon the findings of the WRMR Model V&V Study, which validated the model results for target-oriented munitions. The GAR Study Team documented the munitions requirements development procedures as described and implemented by the Marine Corps and the US Army. To provide an understanding of the Marine Corps process, representatives of MCCDC OAD and LID, Training and Education Command (TECOM,) G-4 AMMO, and the Marine Corps Systems Command (MARCORSYSCOM) were contacted and interviewed. To gain an understanding of the Army's approach to the munitions requirements development process, interviews and communications were conducted with representatives of the Center for Army Analysis (CAA), the G-3/5 and G-4 elements of the Army Staff, and the Training and Doctrine Command (TRADOC). In applicable cases, provided data was available, historical information was evaluated to provide better insights into the accuracy of the methodologies. Working from these comparisons, the GAR Study Team developed results that identified areas where the Marine Corps munitions requirements development process was deficient and offered findings, conclusions and ultimately recommendations for improvement.

2.2.3 Task 3 – Analyze USMC Combat Planning Factors

This task directed the performer to examine methods used by the Marines to develop combat planning factors (CPFs) and the use of these factors for operational planning. The task posed the following key study questions:

- What ammunition planning factors are used by Marine Corps planners and how are they used?
- Are the planning factors calculated by the WRMR model and published as part of the Total Munitions Requirement (TMR) sufficient for operational planning?
- What decision support tools are available to Marine Corps planners to help them determine the tactical ammunition requirements?

The approach focused on exploring the linkage between operational uses of CPFs with the CPFs generated via the requirements process. The GAR Study Team conducted interviews with logisticians, ammunition specialists, and operational planners at the Marine Expeditionary Force (MEF)-, division-, regimental-, and battalion-levels to determine which planning factors are actually used and which decision support tools are available to these planners when they define real-world requirements.

2.2.4 Task 4 – Describe Training Ammunition Requirements Process

This task directed the performer to review methods used to calculate the training ammunition requirements. The performer was directed to meet with the appropriate TECOM personnel in order to understand and document the training process and, where possible, compare estimated requirements with actual usage. The task posed the following key study questions:

- How do the Marines determine training ammunition requirements?
- What improvements have been made in the training and testing requirements process since the NAS audit (June 2006)?
- How do the estimated requirements compare with what was actually expended?

The approach was to define the current process for determining training requirements, compare the status quo with published critiques of the previous process, note efforts made by TECOM to address these critiques, and identify any internal discrepancies discovered in the course of the review. This was undertaken by collecting and organizing data provided by TECOM and G-4 Ammo during interviews and other lines of communication.

2.2.5 Task 5 – Assess Relevance of Analytical Agenda / Analytical Baselines to the Marine Corps Munitions Requirements Development Process

This task directed the performer to determine if and how DoD's current Analytical Agenda process and its associated Analytical Baselines can support the Marines in complying with DoD's overarching guidance for developing munitions requirements. The Analytical Agenda was designed to collect, develop, maintain and disseminate data on current and future US and non-US forces and scenarios in support of strategic analysis. It contains a number of scenarios or vignettes that describe potential points of conflict in varying levels of detail. Some of these scenarios consist only of the textual description from the Strategic Planning Guidance (SPG), while others are more robust and include Multi-Service Force Deployment (MSFD) data. In addition, for theaters with defined OPLANs, the Analytical Agenda maintains the current-year and out-year Analytical Baselines (ABLs), developed by the COCOMs and J-8, respectively, for each of these scenarios. The ABLs include US, allied, and enemy force data as well as the theater's analysis describing the expected scheme of maneuver and timing of major operations. The ABLs are designed to provide a common starting point for all analytical agencies throughout DoD.

The approach involved reviewing the data provided for scenario-specific Analytical Baselines by the Defense Intelligence Agency (DIA) and the combatant commands (COCOMs) to assess accuracy, completeness and timeliness with regard to the Marine Corps munitions requirements development process. The underlying assumptions used by DIA and the COCOMs to generate this data were also assessed to establish whether they accurately reflected the positions and perspectives of the Marine Corps. The GAR Study Team reviewed all relevant documents and established an open dialogue with the COCOM staffs, DIA and the Joint Staff to address questions and concerns.

2.2.6 Task 6 – Document Study Findings

This task directed the performer to document interim and final study findings. Interim study findings on Tasks 1, 2 and 4 were provided in sufficient time to inform the Marine Corps munitions requirements development process in support of POM-10.

The Study's findings and conclusions led to the following recommendations and information being provided to MCCDC prior to the 1 January 2008 submission deadline of the ground ammunition requirements for POM-10:

- Use of an Army methodology to calculate expenditures of obscuration and illumination rounds and comparison to historical USMC usage rates of those munitions for use as a benchmark;
- Use of actual munitions expenditure rates experienced over the past three years in Operation Iraqi Freedom to calculate Phase IV munitions requirements.
- An approach to calculate two training requirements where the first is a baseline that reflects ideal training conditions in which all units successfully complete all their requirements and the second is a variant that captures a more realistic portrait of training expenditures resulting from reduced opportunities for units to train owing to increased operational tempo, deployments, etc.
- Defining the Approved Acquisition Objectives (AAO) as the sum of the TMR and the Peacetime Pipeline (PPL), the latter to be determined by MARCORSYSCOM. (See section 7.2.4.3)

2.3 Structure of the Report

The report is intended to meet two related requirements. First, it is structured to comprehensively address all the tasks assigned to the study. In addition, it is designed to serve as an easy-to-follow tutorial on the munitions requirements development process that can quickly educate future incoming Marine Corps personnel with responsibilities in this area.

The report begins by providing the reader with an historical perspective of the munitions requirements process derived from review of Government-sponsored reports and critiques spanning more than a decade. This is followed by a description of the process as it is currently articulated in DoD and USMC guidance. Next the report documents the munitions requirements development process as it is currently executed in the Marine Corps and proceeds to identify issues, concerns and problems with that execution. The Army's munitions requirements development process is then described to establish areas of potential utility for improving the Marine Corps execution. Subsequently, the report proposes solutions for addressing all issues, concerns and problems identified in the Marine Corps process and execution. Next the report examines the validity of the combat planning factors generated by the WRMR model and assesses their utility to operational planners. Finally, the report presents a vision that lays out an analytical framework, organizational roles and responsibilities and a timeline for each step of an end-to-end munitions requirements development process that aligns with DoD guidance and generates transparent, credible estimates that result in a timely, analytically sound TMR submission.

The following tables support navigation through the report by task and by key study questions.

Task	Relevant Report Section(s)
1. Literature Review	2.2.1, 3, Appex C
2. Army / USMC MRP Methodology Comparison	2.2.2, 4, 5, 6
3. Combat Planning Factor Analysis	2.2.3, 4.2.2, 5.2.2, 7.2.2, 8
4. Test and Training Requirements Generation Description	2.2.4, 4.2.4, 5.2.4, 7.2.4
5. Analytical Agenda Assessment	2.2.5, 4.1.1.5, 5.1.1.5, 7.1.1.5
6. Document Findings	All

Table 2-1: Task-to-Report Matrix

Key Study Questions	Relevant Report Section(s)
Task 2 - How do the ammunition requirements derived from the campaign simulation used by the Army differ from ammunition requirements derived from the WRMR model for both target-oriented and non-target-oriented munitions?	6.2.1
Task 2 - How might the results from the two methods be integrated in the Marine Corps munitions requirements development process to better inform the POM-10 or future POM?	6.4
Task 2 - Are the existing methods an adequate means for determining the current operations/forward presence and the strategic readiness requirements?	7.1.2.5, 7.1.2.6, 7.2.3, and 8
Task 3 - What ammunition planning factors are used by Marine Corps planners and how are they used?	8
Task 3 - Are the planning factors calculated by the WRMR model and published as part of the TMR sufficient for operational planning?	8
Task 3 - What decision support tools are available to Marine Corps planners to help them determine the tactical ammunition requirements?	8
Task 4 - How do the Marines determine training ammunition requirements?	4.2.4
Task 4 - What improvements have been made in the training and testing requirements process since the NAS audit (June 2006)?	7.2.4
Task 4 - How do the estimated training requirements compare with what was actually expended?	7.2.4.1

Table 2-2: Key Study Question-to-Report Matrix

2.4 Assumptions, Limitations and Major Factors for Consideration

As is the case with any estimates associated with a highly dynamic environment, the accuracy of forecasted numbers is impossible to establish and difficult to defend. To quote from a 1991 RAND report entitled Estimating Conventional Munitions Requirements:

> "the fact of the matter is that high confidence, future-oriented, munitions requirements estimates are unachievable. So efforts to achieve such estimates, whether through research, analysis, investment, or testing, are bound to result in disappointment." (Kassing et al, 1991)

Regardless, it is the responsibility of the Marine Corps to develop munitions requirements that are based upon solid analysis with the most accurate data available at the time. This study proceeds from the position that a transparent methodology and a clearly defined division of labor can generate traceable estimates that are credible to senior leaders and will ensure that personnel transition is not the primary cause of fluctuations in future requirement estimates.

This study was chartered to examine the *process* the Marine Corps uses to estimate its munitions requirements. The study charter did not envision the development of shadow results for comparison to the submitted TMR. Consequently, the Study Team executed exploratory runs of the WRMR model for comparative purposes only to determine the impact of specific changes to the input data on the munitions expenditure calculations.

For POM 10, Quantics, Inc., the current maintainers of the WRMR model, delivered two different versions of the executable. The version entitled "WRMR version 2.32 POM-10 With Repairs (27 December 2007)" included repair and return of equipment to the target set, whereas the version entitled "WRMR version 2.32 POM-10 (8 January 2008)" did not. Although the non-repair version was eventually used in the generation of the TMR for POM 10, the GAR Study Team employed the repair version of the WRMR model in the analysis underlying this report. There were two reasons for this decision. First, all previous USMC MRP submissions had been developed with the repair version of the WRMR model. Second, significant work on the study was conducted prior to the delivery of the non-repair version. The study's use of the repair version of the WRMR model will have had no impact on the overall study conclusions and findings. The study focused on performing comparative analysis of WRMR model results to identify trends and relative rates of change owing to differences in input values. Given that the two versions of the WRMR model differ only in the inclusion of repair, then, aside from the implications of the repair function itself, which are addressed in detail in the report, the relative rates of change in other areas of the WRMR model should be consistent across the two versions.[2]

DoD Instruction (DoDI) 3000.4 provides guidance to the Services on how to conduct the MRP. This instruction, entitled *DoD Munitions Requirements Process (DoD MRP),* is dated 23 October 2003, and is currently under review. In the middle of the POM-10 MRP cycle, DoD directed the Services to follow guidance contained in a pre-coordination draft revision of DoDI 3000.4. The GAR Study Team received a copy of this proposed instruction on 31 October 2007. Subsequent revisions of DoDI 3000.4 were also obtained by the GAR Study

[2] Only the version without repair and return of equipment is currently maintained. Representati ves from Quantics, Inc. have indicated that a switch, similar to the one recommended in this report, will be incorporated into the baseline to support POM-12 analysis.

Team. The information in this report refers to the signed, 23 October 2003 version of DoDI 3000.4 unless it is explicitly stated that it is referring to specific proposed revisions.

The GAR Study Team, as directed by the Statement of Work for this effort, utilized defense planning scenarios where necessary and accounted for the increase in the active-duty Marine Corps to 202,000 personnel by FY 2011.

Use of the term "COCOMs" in this report refers to CENTCOM, US Forces Korea (USFK) and PACOM as they are currently the only commands required by the DoD guidance to produce Phased-Threat Distributions in support of the MRP.

This study's scope is limited to the generation of ground ammunition requirements only, as the Marine Corps' fixed- and rotary-wing aviation munitions requirements are developed through the US Navy's Non-Nuclear Ordnance Requirements process.

The GAR Study Team was subject to the availability and willingness of various agencies to provide the information necessary to successfully complete this study. Without exception, organizations throughout the DoD provided timely and invaluable assistance. Within the Marine Corps TECOM, MARCORSYSCOM as well as logistics and ammunition officers at II MEF were readily available for direct meetings and provided extensive insight into their specific roles and operations. The Center for Army Analysis, Army G-4, TRADOC, and Army G-3/5 ensured that the GAR Study Team had a thorough understanding of the US Army's MRP. The J-8 Warfighting Analysis Division (WAD) and Force Application Engagement Division (FAED), CENTCOM, PACOM, and USFK all provided information related to development of the PTDs either through direct meetings or via e-mail. Representatives from Quantics, Inc., were extremely helpful in describing the algorithms, data, as well as the assumptions used in both, which comprise the WRMR model. Finally, the staff at MCCDC LID and OAD were invaluable in not only providing information, but in their assistance in coordinating meetings, reviewing the study team's findings, and ensuring that the study effort was able to progress in an efficient manner. Each of these organizations was critical to the successful completion of this report.

3 Munitions Requirements Process

This section is intended to provide a context for understanding the evolution of the munitions requirements development process. It begins with a discussion of various reports and critiques of the process dating to the 1990s and then describes the authoritative guidance that is in place today for executing the process.

3.1 The Munitions Requirements Process – An Historical Perspective

The literature review identified three key documents which define how munitions requirements are to be developed. DoD Instruction (DoDI) 3000.4 signed in 2003 and entitled *DoD Munitions Requirements Process (DoD MRP),* and proposed revisions of it (a pre-coordination draft obtained by the GAR Study Team in October 2007, a proposed revision version 4 obtained in March 2008, and a proposed revision version 6 obtained in April 2008), define the roles and responsibilities of DoD agencies, the COCOMs and the Services. Marine Corps Order (MCO) 8000.7, *Marine Corps Capabilities-Based Munitions Requirements (MCCBMR) Process for Ground Ammunition,* defines the Marine Corps process to be used to execute the DoD guidance. The literature search also revealed multiple reviews by internal and external organizations that critiqued both the structure and implementation of the processes. This section documents the evolution of the munitions requirements process as marked by the publication of both formal guidance and associated critiques.

The problems of determining each Service's munitions requirements through an analytical process have existed for decades. RAND generated two reports in 1991 addressing the problems of both the entire DoD process for generating requirements, as well as another report focusing solely on the USMC process.

The first of these reports, *Estimating Conventional Munitions Requirements: Toward Improved Processes,* noted the absence of a coordinated approach between the Services, the DoD and the COCOMs to produce munitions requirements. Each Service used a unique methodology to calculate requirements, meaning each Service incorporated different scenarios, data, and assumptions into their estimates. The report noted that the fidelity of the scenarios varied widely between the Services; the Army and Air Force failed to account for resupply; only the Air Force accounted for the value of a target; the Army and Marine Corps calculated ground ammunition requirements without regard to the role of cost effectiveness; and the interpretation and choice of confidence levels in combat consumption varied between each of the Services. According to the report, the requirements were not linked directly to warfighting measures of effectiveness and the COCOMs' mission needs were frequently not incorporated into the final requirements. (Kassing, 1991)

The second report, *The Marines' Ground-Attack Conventional Munitions Requirements Process,* expanded on some of these shortfalls, noting that the Marine Corps methodology failed to account for the constraints of the logistics system. In addition, it noted that

modeling a single theater prevented the Marine Corps from properly accounting for uncertainty. To account for the fog of war and potential changes to the operational environment in this scenario, the Marine Corps would simply increase the single estimate. The report stated that this single, increased requirement was then provided to the decision-makers while the effects of the uncertainty were concealed. (Girardini, 1991)

The DoD attempted to resolve many of the issues documented in RAND's *Estimating Conventional Munitions Requirements* report by issuing DoDI 3000.4 on 10 August 2001. In a review of this instruction by the Government Accountability Office (GAO) entitled *Munitions Requirements and Combatant Commanders' Needs Require Linkage* and submitted to the Secretary of Defense in October 2002, the GAO found that inadequate linkage between the near-term munitions needs of the COCOMs and the purchases made by the military Services remained a problem. Also, the instruction did not provide the means for the COCOMs to be engaged in the requirements determination process, budgeting process and related purchasing decisions.

In response, DoD revised 3000.4 and issued a new version on 23 October 2003. It defined the roles and responsibilities of DoD agencies, the Services and the COCOMs in generating munitions requirements. In an effort to ensure that each of the Services would base its requirements upon like conflicts, the instruction directed that Under Secretary of Defense (USD) for Acquisition, Technology, and Logistics (AT&L) guidance be followed for scenario selection. In addition, each Service was directed to use the threat forces as defined by the DIA and generate their requirements with a target-based approach, with the COCOMs assigning each Service the quantity of each type of target to be neutralized.

In a letter provided to the Secretary of Defense on 12 August 2005, the GAO noted that the Services had not complied with the October 2003 DoDI 3000.4 and the draft update being developed by the DoD failed to provide any control criteria to ensure compliance. The letter also reported that DIA had failed to coordinate with USFK while developing that theater's threat report, only the USAF coordinated with USFK prior to modeling its munitions requirements and no Service coordinated the results of their modeling efforts with USFK. In addition, the GAO letter stated that the instruction did not require COCOM participation in risk assessments associated with inability of the Services to purchase the required munitions.

The aforementioned documents are primarily focused upon the munitions requirements process as viewed from the DoD perspective. A number of other studies have specifically addressed the Marine Corps munitions requirements development process. The report of the Ground Training Ammunition Review Group (GTARG) submitted on 28 August 1998 developed a baseline training requirement for fiscal year 2000, which was designed to reduce the cost of training ammunition by 5% annually from FY00 to FY05. This baseline has been used to develop all training requirements since 2000. As noted above, the NAS review of the USMC munitions requirements development process found significant, broad-based flaws in the Marine Corps' methodology.

The Center for Naval Analysis (CNA) expanded upon this in its July 2006 report, *Funding*

and Management of the Marine Corps' Ground Ammunition. This study found a substantial shortfall in the ground ammunition program funding as recent expenditures out-paced procurements. The report noted that the USMC munitions requirements development process is governed by two outdated orders, MCO 8000.7 and MCO 8010.1E, *Class V(W) Planning Factors for Fleet Marine Force Combat Operations,* leading to requirements of questionable credibility. CNA could find no evidence that the Executive Steering Committee for Ammunition (ESCA), a senior-level policy-making body chartered to provide guidance to the munitions requirements development process per MCO 8000.7, had ever met. The report also stated that methods to determine priorities when funding fails to cover stated requirements are not clearly defined. (Klein, 2006)

Following the WRMR Model V&V Study undertaken in response to NAS review, an accreditation letter for the model was submitted in the fall of 2007 by the Senior Analyst for CG MCCDC. This letter indicated that the model is verified and valid and should be used for POM-10 analysis with the understanding that the model will continue to undergo improvements.

The previous reports, studies and critiques provided a very general and vague description of the flaws associated with the USMC munitions requirements development process. This study aims to provide a more detailed and thorough description of the USMC munitions requirements development process, precise explanations of any issues, concerns and problems it identifies, and prescriptions for resolving them. The recommendations presented within this report are intended to enable the USMC to produce a total munitions requirement that is based upon analytical rigor, generated via a well-defined and historically consistent process, with senior-level oversight and review of the inputs as well as the outputs of the process.

3.2 DoDI 3000.4 (signed version from October 2003)

Through DoDI 3000.4, entitled *DoD Munitions Requirements Process (DoD MRP),* each Service is required to perform a munitions requirements process every even-numbered year. The Office of the Secretary of Defense (OSD) is revising this instruction to address the issues discussed in the most recent GAO letter to the Secretary of Defense, primarily to address inclusion of the COCOMs in the risk assessment and purchasing processes.

DoDI 3000.4 directs the Defense Intelligence Agency (DIA) to develop threat reports (TRs) for operations specified in the Defense Planning Guidance (DPG, which at the time of this report was changed to the Strategic Planning Guidance or SPG) and Contingency Planning Guidance (CPG). It also guides each COCOM to generate a near-year[3] Phased Threat Distribution (PTD) and the Joint Staff to develop an out-year[4] PTD, which are then to be

[3] DoDI 3000.4 defines this as October 1 of the year following the calendar year the Service DoD MRP requirements are submitted (i.e., if DoD MRP reporting is March 15, XX, then near-year is October 1, XX+1).

[4] DoDI 3000.4 defines this as September 30 of the last year of the FYDP.

used by the Services to develop their munitions requirements. The final munitions requirement must address the operational objectives of the COCOMs, consider logistical capabilities and constraints, and retain residual capability to perform continuing missions and support Current Operations/Forward Presence Requirements (CO/FPR). This process flow is described in Figure 3-1 below and discussed in detail in the following sections. The boxes highlighted in purple and blue represent the portions of the overall munitions requirements process that are applicable to this study.

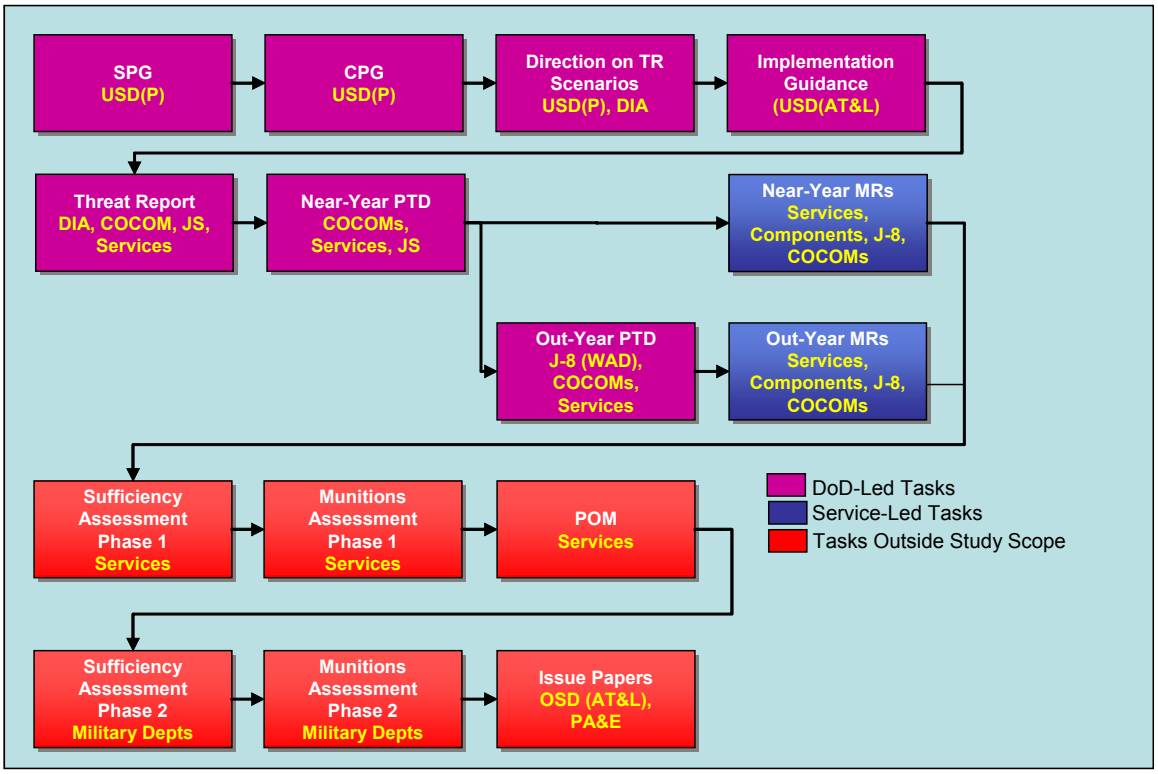

Figure 3-1: DoDI 3000.4 Munitions Requirements Process

3.2.1 DIA Threat Reports

The Under Secretary of Defense (USD) for Intelligence ensures that the DIA publishes near- and out-year Threat Reports (TRs) using direction from the current SPG, mid-term Defense Planning Scenarios (DPS), and coordinated threat projections from the DoD Futures Database. These TRs are to be distributed to the Chairman of the Joint Chiefs of Staff (CJCS), the COCOMs, each Service's Munitions Requirements Office, the USD for (AT&L), the Director of Program Analysis and Evaluation (DPA&E), and other DoD participants included in the coordination by July 1 of every odd-numbered year to support the development of the PTDs and munitions requirements. The TRs are to be reviewed in even-numbered years and recipients of the TRs are either to be told that no changes are required or they are to be issued a new TR.

Each Service is to collaborate with the DIA to develop standard target templates and review

the near- and out-year TRs for completeness and accuracy, ensuring they reflect both the quantitative and qualitative threats for each theater. In addition to the Services' review of the TRs, the near-year TRs are to be reviewed by the COCOMs and the out-year threat data are to be reviewed by the CJCS.

Each TR is to include the target databases used to develop the target quantities and should include the target name, location in latitude and longitude, Basic Encyclopedia (BE) number, category code, vulnerability, hardness, depth, radius, capacity, and TR category, type, and model. The list is also to identify known priority targets as well as the quantities of estimated future targets. In addition, the DIA TR is to provide estimates of target reconstitution/regeneration rates, battle-damage assessment (BDA) rates, as well as representative target templates for multi-element, fixed-target types.

3.2.2 Phased-Threat Distributions

Working from the total theater target picture developed in the TR, near-year PTDs are developed by the COCOMs and must include a Strike Favorable case, where strike platforms/weapons perform to the greatest extent possible, and a Strike Unfavorable case, where degraded strike platforms/weapons capabilities result in more targets being destroyed by maneuver forces. These PTDs are to allocate the type and number of targets to the ground and air components of each Service by phase of the Operation Plan (OPLAN) and are to include the assumptions and methodology used in the analysis.

Prior to submission, the COCOMs are to coordinate near-year PTDs with the Services and the CJCS to ensure the PTDs are aligned with the OPLAN concepts. Comments and inputs are to be either incorporated into the near-year PTDs or attached as an appendix. Near-year PTDs are used to support COCOM risk assessments.

Out-year PTDs are developed by the CJCS and must also include Strike Favorable and Strike Unfavorable cases and describe, in detail, the assumptions and methodology used in the analysis. Out-year PTDs require coordination with the COCOMs to ensure they are aligned with the OPLAN concepts and the Services to ensure modernization requirements are aligned. Comments and input received are to be either incorporated into the PTD or attached as an appendix. These out-year PTDs are to be released by the 15th of October every odd-numbered calendar year to the COCOMs, the Services, the USD (AT&L), and the Director of PA&E. Out-year PTDs support munitions estimates for acquisition.

3.2.3 Munitions Requirements

The Secretaries of the Military Departments are to work directly with the Service components and COCOMs to develop near- and out-year munitions requirements according to the SPG, CPG, and PTDs.[5] Two near-year requirements are to be developed, the first set

[5] It is important to understand the impact and usefulness of the near-year and out-year requirements. The out-year requirements are the most critical in determining procurement, as procurement is initiated years before delivery of the

using projected inventories, and a second "unconstrained" set which is directed to not be limited by projected inventory or funding but may be limited by reasonable production capacity, weapon system capabilities, and externally defined caps on procurement. The out-year requirement identifies the optimal mix of munitions for the warfighter, and is not to be constrained by projected inventory, munitions cost, funding, production capacity limitations, or externally defined caps on procurement. The out-year requirement is only to be constrained by the funded weapon systems and their funded capabilities. The Services use the 'Strike Favorable' or 'Strike Unfavorable' PTD that requires the greatest weapon expenditures on their part to determine these requirements.

Near- and out-year munitions requirements are to account for strategic readiness requirements (SRR) which represent the needs of forces not committed to the operations specified in the current SPG and CPG, whether these forces are forward deployed, in the continental United States, or in the Active or Reserve components. Any additional munitions requirements generated from treaties or statutory obligations to allies are also to be included. Near- and out-year munitions requirements are also to account for CO/FPR to provide combat capability for forces as defined in the current SPG. As Figure 3-2 below shows, the sum of the combat requirements (CR), the SRR and the CO/FPR defines a war reserve munitions requirement (WRMR). The WRMR is then combined with a near- and out-year Training and Testing Requirement (TTR), which must consider force structure, mission, and modernization, to arrive at the Total Munitions Requirements (TMR).

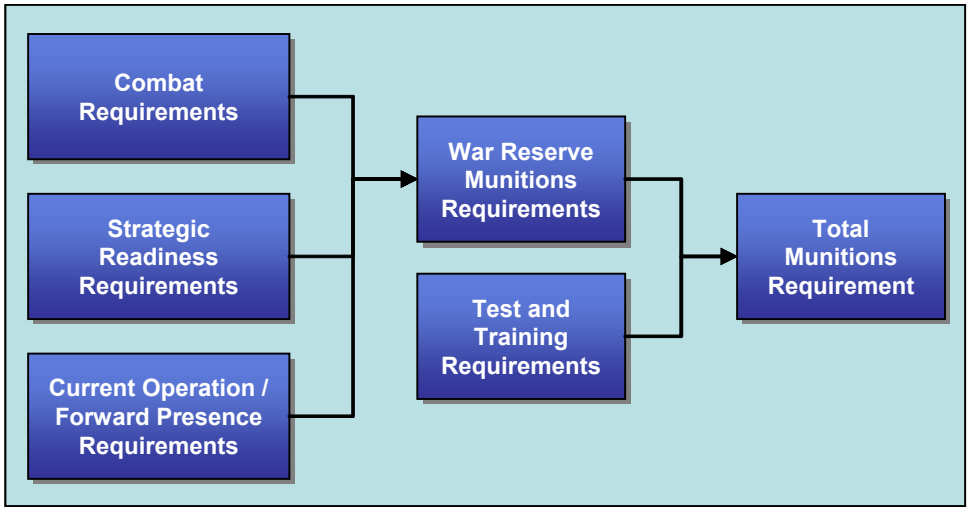

Figure 3-2: Calculation of the Total Munitions Requirements (TMR)

The near-year munitions requirements are to be coordinated with the COCOMs to ensure munitions requirements support near-year PTD and war plans. The out-year munitions requirements are to be coordinated with the COCOMs and Service components to identify and address shortfalls and highlight long-term inventory objectives, and with the CJCS to

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munitions. The near-year requirement, therefore, has minimal impact on the POM process and procurement objectives. It is used primarily to determine current sufficiency and to estimate risks to each theater.

ensure alignment with the out-year PTD. Any inputs received by these organizations are to be either incorporated into the munitions requirements or attached as an appendix to the MRP submission.

The near-year munitions requirements and a detailed description of the methodology used are to be submitted to the CJCS, the COCOMs, and the Service components by March 15th annually. Out-year munitions requirements and their associated methodologies are to be submitted to the USD (AT&L) and the Director of PA&E by March 15th annually.

These munitions requirements are then used as input to the Service POM development process.

3.3 DoDI 3000.4 Proposed Revisions

Normally, it would be inadvisable to include draft versions of instructions or other documents in a final report. In this instance, the draft revisions have held more authority than usual, given that DoD mandated that the Services attempt to align their POM-10 MRP efforts with the October 2007 pre-coordination draft. It is also anticipated that the POM-12 MRP cycle, which will start in October of 2008, will likely be guided by the latest update of DoDI 3000.4, regardless of whether it has been signed. Hence, it seems imperative to examine the new roles and organizational responsibilities as they have evolved in draft versions of this document.

USD (AT&L) is currently developing a proposed revision of DoDI 3000.4. The revision process has been on-going over the past four years, with conflicts and noted issues preventing finalization and signing of a new instruction. The most recent draft version, version 6, was received by the GAR Study Team in April 2008. The key differences between this proposed revision, other previously proposed revisions, and the 2003 signed version are summarized in Table 3-1 below and described in detail as follows:

- Versions 4 and 6 represent a significant change in the scope of the instruction itself. These versions provide only an overview of the process, with details provided in enclosures. To provide further explanation, DoD intends to develop an MRP Manual with detailed guidance and lessons learned from previous MRP cycles.

- In versions 4 and 6, newly formed organizations, such as the Joint Analytic Data Management Steering Committee (JADM SC) and the MRP Working Group, are supposed to increase coordination between the products used and produced by the MRP and the Analytical Agenda, and to improve coordination and resolve outstanding issues between DoD, CJCS, the COCOMs and the Services. These efforts at improving coordination are integral to the latter proposed versions of this instruction as DoD, the COCOMs, CJCS, and the Services are to coordinate on nearly all major products developed during the MRP.

- The definition of the TMR is only found in the glossary of versions 4 and 6, and is defined as the sum of “planned combat expenditures, current operational / presence

missions, treaty obligations, and testing and training requirements." This definition omits the strategic readiness requirement from the TMR.

- In version 6, the definition of CO/FP forces is to be performed by the CJCS in coordination with the Under Secretary of Defense for Policy USD(P), the COCOMs and the Services. This is a deviation from version 4 in which the CO/FP for each Service was to be defined by USD(P) and presented in the Implementation Guidance, as well as from the 2003 instruction which assigns this responsibility to each of the Services.

- DIA maintains the responsibility for developing threat data, but this is now composed of Dynamic Threat Assessments (DTAs) and Joint Country Force Assessments (JCOFAs) and is no longer referred to as "threat report."

- Per versions 4 and 6, a total of four TMRs will be produced, including constrained and unconstrained, near- and out-year TMRs. The near-year unconstrained TMR provides insight to near-term funding issues and potential Service reprogramming prior to the Future Years Defense Program (FYDP). The near-year constrained TMR provides a means to assess risk to an OPLAN/CONPLAN, assists in the prioritization of munitions pre-positions and allocation issues, and gives insight to initial funding issues entering the POM process. The out-year unconstrained TMR represents the Services' munitions inventory objectives, and the out-year constrained TMR will be addressed via the Sufficiency and Munitions Assessments. In the original DoDI 3000.4, an out-year constrained TMR was not addressed and it is unclear which organization is responsible for generating this TMR.[6]

- Versions 4 and 6 also have the CJCS responsible for presenting the out-year PTDs and Service TMRs for Joint Requirements Oversight Council (JROC) validation, and submitting these documents to the Director of PA&E via the JADM SC.

- The latest version of the proposed revision maintains the same timeline for the major deliverables (TRs, PTDs, TMRs, and Risk and Sufficiency Assessments) although, according to the MCCDC ARO, the Air Force has proposed a new timeline with the TRs due in mid-December, near-year PTDs due by 1 March, out-year PTDs due by 1 May, and TMR submissions from the Services to OSD completed by 1 November. As of the information-cutoff date for this report (end of April 2008), however, concurrence from the COCOMs had not yet been received and no new proposed revision to the instruction identified these dates as final.

- Version 6 fails to resolve many of the issues identified by the MCCDC ARO in his

[6] This report will only refer to the near-year constrained and unconstrained and the out-year unconstrained TMRs. This is due to the fact that these TMRs are consistent with the definition or requirements defined in earlier versions of DoDI 3000.4 and that it appears that the out-year constrained TMR is to be developed via the Sufficiency and Munitions Assessments, a portion of the MRP cycle that is outside the scope of this report.

Comments Matrix submitted in relation to the October 2007 pre-coordination version of the instruction. However, it is possible these issues will be addressed in the promised MRP Manual.

Subject	2003 Signed DoDI 3000.4	2007 Pre-Coordination Draft	2008 Proposed Version 6 Draft
Source of Guidance	All guidance self-contained	All guidance self-contained	Detailed guidance provided in MRP Manual
Coordination Mechanism	USD (AT&L) sponsors MRP Kick-off Meeting	USD (AT&L) sponsors MRP Kick-off Meeting	DoD MRP Working Group composed of DoD, COCOM and Service representatives meets monthly
WRMR Definition	CR + CO/FPR + SRR	CR + CO/FPR + SRR	CR + CO/FPR
Organization Defining CO/FP Capabilities	Services	Services guided by Analytical Agenda	CJCS
Resultant TMRs	Unconstrained Near-Year, Unconstrained Out-Year, Constrained Out-Year	Unconstrained Near-Year, Unconstrained Out-Year, Constrained Out-Year	Unconstrained Near-Year, Unconstrained Out-Year, Constrained Out-Year, conflicting guidance regarding Constrained Near-Year

Table 3-1: Significant Changes in DoDI 3000.4

3.4 Marine Corps Order 8000.7

This order is the formal guidance for the Marine Corps munitions requirements development process. It predates the current DoDI 3000.4 by more than six years and contains numerous procedures that are in conflict with the governing DoD instruction.

MCO 8000.7 assigns the CG MCCDC as the executive agent for the process. This position is responsible for Marine Corps policy direction and coordination of the munitions requirements development process, including representation to the OSD, the Department of the Navy, and the Joint Staff.

The order also requires the establishment of the Executive Steering Committee for Ammunition (ESCA). This committee, with the CG MCCDC as Chairperson, is composed of the Deputy Chiefs of Staff (DC/S), since renamed as Deputy Commandants, for Plans, Policy, and Operations (PP&O), Installations and Logistics (I&L), Aviation, and Programs and Resources (P&R). Along with the Commander of Marine Corps Systems Command

(COMMARCORSYSCOM), they are to approve policy recommendations formulated by the Ammunition Working Group (AWG). As noted earlier in this report, a CNA study in 2006 could find no evidence that the ESCA had ever met. Thus, it is unclear which senior officers have reviewed and approved the policies that have previously been used to determine munitions requirements.

The AWG is composed of representatives from the ESCA member organizations and serves as a formal policy advisory group to the ESCA. The chairperson, as designated by CG MCCDC, develops the agenda and supporting information for meetings, publishes the results of the meetings, noting areas that cannot be reconciled, and reconciles all comments, conclusions, and recommendations which are then submitted to his staff principal for approval.

MCO 8000.7 defines a 12-step process to determine procurement objectives. Over the decade since the order was signed, the implementation has evolved. The roles and responsibilities of each agency in support of this process are illustrated in Figure 3-3 below.

This 12-step process is to be completed in time for COMMARCORSYSCOM to prepare and submit ammunition POM initiatives to compete with other Marine Corps procurement priorities. Accordingly, this process must be conducted once every two-year POM cycle, and is to be completed no later than the end of January of the POM year.

A proposed update to MCO 8000.7 has been developed by the MCCDC ARO, which, is currently being staffed and awaiting signature.

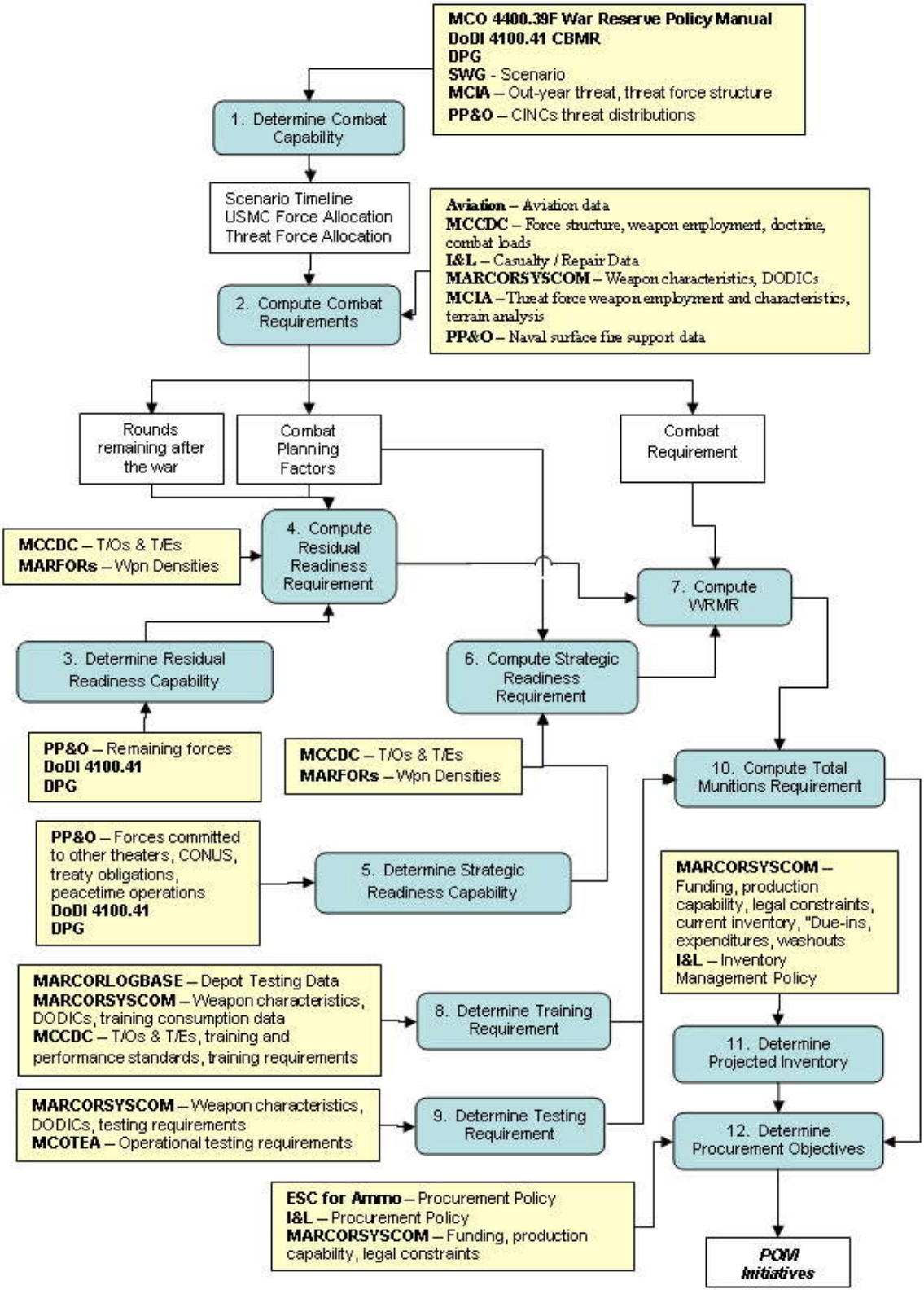

Figure 3-3: Marine Corps Munitions Requirements Process per MCO 8000.7

4 Current USMC MRP

The MRP is performed in a two-year cycle starting in October of even-numbered years. Submission of constrained and unconstrained Marine Corps TMRs for both the near-year and out-year is the responsibility of MCCDC's Ammunition Requirements Officer (ARO). This is currently a lieutenant colonel (O-5) billet with a three-year tour of duty and is supported by a gunnery sergeant. The ARO submits the TMR to DoD in January of even-numbered years to support the POM process and possibly produce an "interim" TMR in January of odd-numbered years, which supports the Program Review (PR) if significant changes have occurred that will affect the TMR.

The Marine Corps relies heavily on its WRMR model to generate the TMR. The WRMR model was purpose-built for the Marines as the successor to the Marine Corps Ammunition Requirements Management System (MCARMS) database that was used throughout the 1980s and 1990s. The WRMR model performs the calculation of munitions requirements estimates and produces combat planning factors as a by-product of this role that are made available for use by operational planners. The WRMR model combines force flow and operational tempo provided by the COCOMs, weapon effectiveness data from the Joint Munitions Effectiveness Manuals (JMEM), and SME-supplied data for various elements, to produce the combat requirement for the Win Decisive (WD) and Swiftly Defeat (SD) scenarios. Combat planning factors are generated based on the daily expenditure rates in these scenarios that are then used to determine CO/FP and SR requirements. Training expenditures provided by TECOM are added to the WRMR-derived estimates in the build-up of the final submission.

The MCCDC ARO is responsible for producing three separate TMR products: unconstrained and constrained versions for the near-year and an unconstrained version for the out-year. The near-year and out-year unconstrained versions are produced via a single WRMR model run. The constrained run is contingent upon MCCDC receiving the constraining factors (current inventory, production capability, etc.) from MARCORSYSCOM. As a point of interest, a WRMR model run actually spans 10 years, outputting the requirements for each year. For POM-10, the maintainers of the model changed the format of the output to only show the near-year and out-year results.

Owing to conflicts driven by the time lag between MCO 8000.7 dating to 1997, the 2003 signed version of DoDI 3000.4 and the 2007 pre-coordination draft stipulated for use in POM-10 by DoD, MCCDC has been forced to employ ad-hoc measures for its MRP. Figure 4-1 below illustrates the sequence of events and actions through which the MCCDC ARO executed the POM-10 MRP and produced the TMR products.

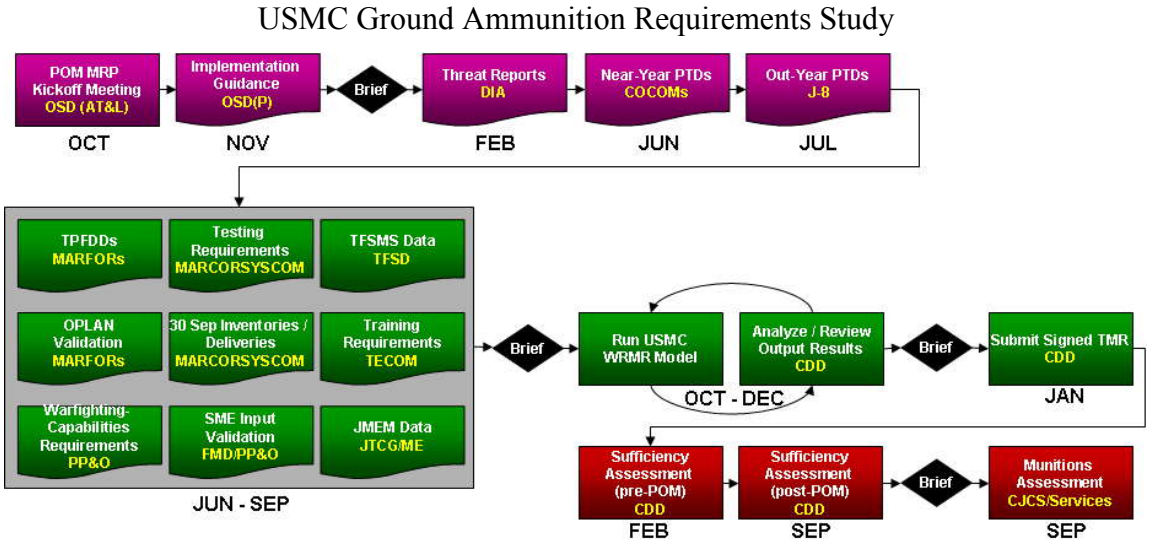

Figure 4-1: MCCDC ARO's Execution of MRP for POM-10 Process

Figure 4-2 provides an alternerative view of this process, aligning it closely with the guidance provided in the pre-coordination draft of DoDI 3000.4 and separating the tasks into three distinct phases: Data Collection; Development of TMR; and Validation. Each phase is discussed in detail below.

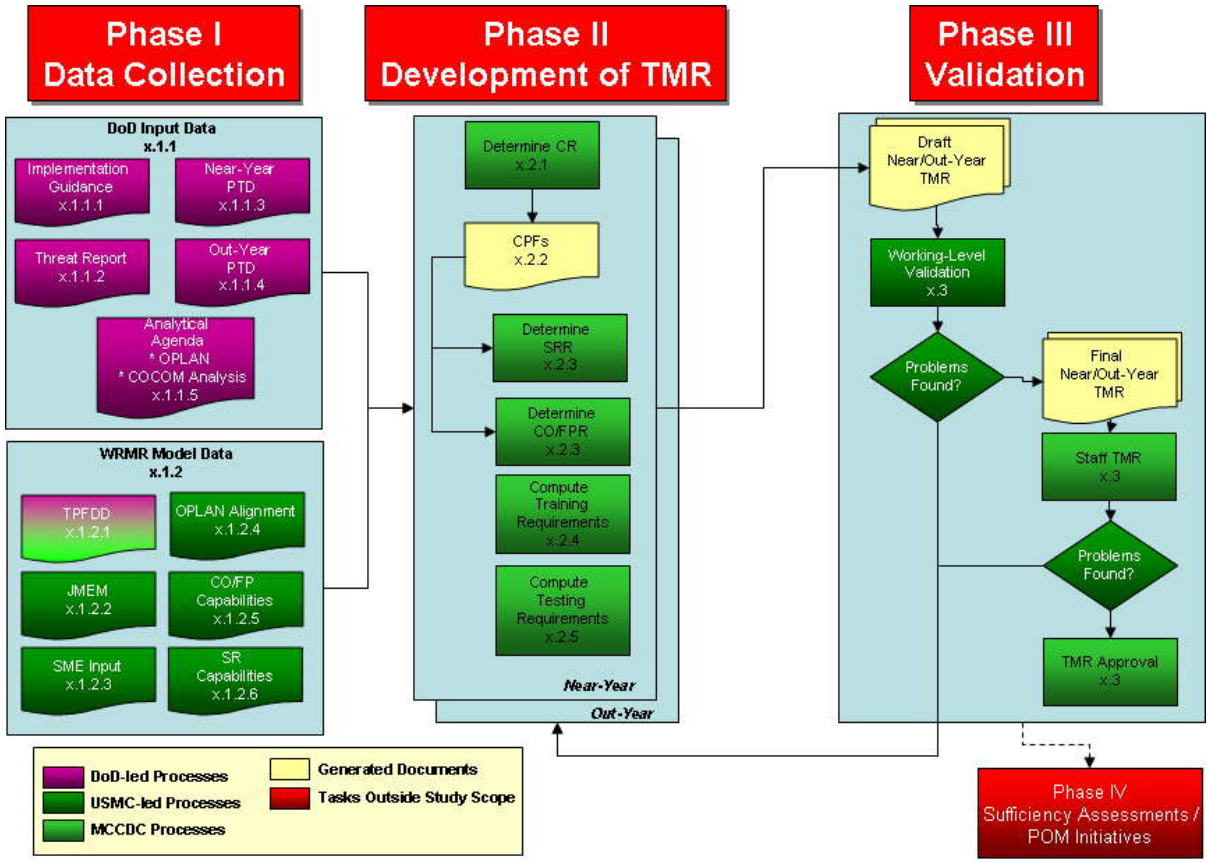

Figure 4-2: Conceptual Diagram of Current Marine Corps Munitions Requirements Process[7]

4.1 Phase I: Data Collection

The purple blocks in Figure 4-2 above represent DoD-led efforts defined in DoDI 3000.4 that provide the input scenarios and data required by MCCDC and the WRMR model to generate the munitions requirement. It includes the Implementation Guidance produced by USD (AT&L) which provides information pertaining to the scenarios to be used, the Threat Report produced by DIA which contains enemy target information and associated repair capabilities, as well as the near-year and out-year PTDs generated by the COCOMs and J-8, respectively. In addition, the pre-coordination draft of DoDI 3000.4 utilized by each of the Services during the MRP to generate POM-10 initiatives required the use of the Analytical Agenda for any additional scenario-related data.

In the following sections, the current methodologies associated with each of these tasks are detailed. Issues, concerns and problems identified by the GAR Study Team and additional

[7] The numbers on the flowchart represent the section of the report in which the given block will be discussed. For instance, the current methodology for Implementation Guidance will be presented in Section 4.1.1.1, the problems with the current methodology will be presented in Section 5.1.1.1, and the proposed solutions will be presented in Section 7.1.1.1. This numbering format also pertains to figure 4-5.

commentary are then provided in the corresponding sections of Chapter 5, and proposed solutions are defined in the corresponding sections of Chapter 7. Hyperlinks are provided at the end of each section to allow easy navigation between these chapters, with page numbers also provided to assist readers working with a non-electronic version of this document.

4.1.1 DoD-Generated Data

4.1.1.1 Implementation Guidance

USD (AT&L) provides the Implementation Guidance in November of even-numbered years to each of the Services and COCOMs. The latest version of this classified letter provided a Win Decisive (WD) scenario and two Swiftly Defeat (SD) scenarios that were to be evaluated. It then directed the Services to combine the expenditures of the WD scenario with the expenditures from the SD scenario requiring the greatest expenditures to compute the total combat requirement.

Link: 5.1.1.1 – Problems with and Commentary on Implementation Guidance (Page 68)

Link: 7.1.1.1 – Proposed Solutions for Implementation Guidance Deficiencies (Page 101)

4.1.1.2 Threat Reports

As directed by DoDI 3000.4, DIA produces the near- and out-year threat reports (TRs, which are called Dynamic Threat Assessments or DTAs in Version 6 of the revisions to DoDI 3000.4). A TR for a given theater combines order of battle information from the Joint Country Force Assessment (JCOFA) database to develop a list of maneuver targets and information from the Modernized Integrated Database (MIDB) to develop a list of fixed targets. TRs are submitted to the Joint Staff and COCOMs for coordination by February 1st of odd-numbered calendar years. The COCOMs distribute draft TRs to the theater Service representatives and/or intelligence organizations for review and corrections.

On March 1st of odd-numbered years, DIA distributes the final version of the TRs. This usually consists of two separate files, a document containing descriptive information of the process and an explanation of the target quantities which are presented in tables within the document, as well as a spreadsheet containing a break-out of all the fixed targets, including location, BE, category code, TR category type, and similar descriptive information.

The Marine Corps Intelligence Activity (MCIA) provides information pertaining to enemy naval infantry, riverine and paramilitary type national police forces to the JCOFA database. This data is provided down to the battalion level for each of the 21 countries on the JCOFA list. This includes estimates used in the 20-year forecast based on the current information available at the SECRET/NF level. The out-year estimates are entered into the Order of Battle Generation and Relation Engine (OGRE) database accompanied by a narrative detailing the assumptions made in developing the projected numbers. All of the information generated by MCIA in supporting the JCOFA is to be reviewed every two years.

Link: 5.1.1.2 – Problems with and Commentary on the Threat Report (Page 69)

Link: 7.1.1.2 – Proposed Solutions for Threat Report Deficiencies (Page 101)

4.1.1.3 Near-Year PTDs

Per all versions of DoDI 3000.4, the COCOMs are responsible for generating the PTDs. The signed 2003 version of DoDI 3000.4 states that these PTDs should include two different scenarios, a 'Strike Favorable' case in which weather and operating conditions increase the ability of air platforms to engage and destroy targets, as well as a 'Strike Unfavorable' case where weather and operating conditions reduce the effectiveness of air platforms, thereby increasing reliance on ground systems to destroy enemy targets.

Each COCOM currently uses unique approaches to developing the PTD. For example, in its 2007 PTD submission, USFK combined modeling results from multiple campaign-level models to determine maneuver target attrition. To determine fixed-target attrition, USFK analysts used the level-of-effort each Service contributes to the various target sets during the Pre-Integrated Tasking Order (pre-ITO) period[8] and combined this information with best military judgment and other target-specific analytical techniques. CENTCOM, however, developed its PTD using modeling results derived from the Joint Integrated Contingency Model (JICM).

Review of the PTDs varies across the generating organizations. USFK distributes a draft PTD to each of the Services' local representatives, including: the Ground Component Command and Eighth Army; the Air Component Command represented by 7th Air Force; and MARFOR-K, which in the past has also forwarded the draft to III MEF or MARFORPAC for review. CENTCOM and PACOM, however, generate and submit their PTDs without this "local" validation process.

Upon submission of the PTDs to DoD, the Services review and comment on the PTDs, and may concur, non-concur, or request modifications or clarification on identified problems.

Link: 5.1.1.3 – Problems with and Commentary on Near-Year PTD (Page 70)

Link: 7.1.1.3 – Proposed Solutions for Near-Year PTD Deficiencies (Page 102)

4.1.1.4 Out-Year PTDs

Development of the out-year PTDs is the responsibility of the J-8 Force Application Engagement Division (FAED). Upon receiving the order to produce a PTD, J-8 FAED enlists the modeling expertise of J-8 Warfighting Analysis Division (WAD) to determine the Service target apportionments over each phase of the campaign.

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[8] The pre-ITO defines a list of scheduled sorties to be flown given a conflict occurs with little or no warning period. It is updated annually by the theater's Air Component Command.

For Marine and Army ground forces, J-8 WAD uses the same Service-specific apportionments from the near-year PTD to allocate targets established in the out-year TR. Thus, if the Marines were tasked to destroy 30% of a given target set in a given phase in the COCOM-generated near-year PTD, then the Marines would also be tasked with destroying 30% of that target set in the out-year PTD, regardless of changes in the future threat, U.S. force structure and operational environment.

For air forces, the total apportionment across the Service air components in the COCOM-generated near-year PTD is re-evaluated by J-8 WAD using the Conventional Targeting Effectiveness Model (CTEM) model. This linear program model optimizes the allocation of shooters to targets defined in the out-year TR. During this re-evaluation, J-8 WAD accounts for anticipated changes in air platforms, force flow, and the introduction or retirement of weapon systems and munitions.

Once the out-year PTD is completed and reviewed by J-8 FAED it is distributed to the Services for comment. This distribution includes the Army G-3, Air Force A-5, Navy N-81, and MCCDC for the Marine Corps.

Link: 5.1.1.4 – Problems with and Commentary on Out-Year PTD (Page 71)

Link: 7.1.1.4 – Proposed Solutions for Out-Year PTD Deficiencies (Page 103)

4.1.1.5 Analytical Agenda

The Analytical Agenda is an effort by the DoD to develop and support a common set of data and utilities to perform strategic analysis throughout the military community. The roles and responsibilities of the various organizations involved in the development of the products of the Analytical Agenda are defined in DoDIs 8260.2, dated 21 January 2003, and 8260.01, dated 11 January 2007.

DoDI 8260.2 “implements policy, assigns responsibilities, and prescribes procedures for generating, collecting, developing, maintaining, and disseminating data on current and future US and non-US forces in support of strategic analyses conducted by the Department of Defense”, and also establishes the Joint Analytic Data Management Steering Committee (JADM SC), a body designed to assist in implementing the procedures outlined in the instruction.

The Director, PA&E, chairs the JADM SC and is responsible for leading the development and maintenance of ABLs used in strategic analyses of future forces. USD(P), in coordination with the heads of the DoD Components, prioritizes, develops and/or updates, and distributes scenarios for strategic analyses at least every two years and identifies critical planning factors for use in strategic analyses. The CJCS, in coordination with the heads of the DoD Components, leads the development, maintenance, and has release authority for the current-year ABLs. With the Director, PA&E, the CJCS also annually prepares a multi-year program for developing ABLs based upon the prioritization of scenarios identified by USD(P). The heads of the Components provide timely and validated Component-specific

data for the ABLS, use the ABLs, if possible, as a starting point for strategic analysis, and provide a representative to the JADM SC. The MCCDC Senior Analyst currently represents the Marine Corps on this body. The Director, DIA, and the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence also provide timely and validated all-source, non-US data for the ABLs.

The ABLs, once created, are managed by the Joint Data Support (JDS) organization under the Director of PA&E. JDS specifies the data required to support development of the ABLs, performs verification checks on data received, and manages the data repository of the ABLs and supporting data. All organizations requiring access to an ABL must submit a request to JDS identifying the point of contact for the request, the purpose of the analysis, an explanation of how the data will support the analysis, and indicate if the organization intends to disseminate the data to foreign nationals. JDS maintains a file showing the status of all ABL requests for review by the DoD components. JDS then requests the approval of the release authorities, the CJCS for the current-year baselines and D, PA&E for future-year baselines, and upon approval distributes the baseline and simultaneously informs all JADM SC members of the distribution.

The 11 January 2007 version of DoDI 8260.01 supersedes one dated 6 December 2002 and updates policies governing the development and management of data, tools and ABLs. The roles and responsibilities presented are generally consistent with and reinforcing of those defined in DoDI 8260.2 and, while minor modifications of roles and responsibilities are presented, DoDI 8260.01 does not mention or alter the composition or role of the JADM SC or the JDS.[9]

Link: 5.1.1.5 – Problems with and Commentary on the Analytical Agenda (Page 71)

Link: 7.1.1.5 – Proposed Solutions for Analytical Agenda Deficiencies (Page 103)

4.1.2 WRMR Model Data Requirements

In addition to the implementation guidance and other data generated by the DoD and COCOMs, the WRMR model requires additional data prior to being able to perform the calculations that will determine the combat requirements. This includes JMEM lethality data, extensive SME-supplied data, and Time-Phased Force Deployment Data (TPFDD) defining the flow of USMC forces into theater, which are required for the model to generate dynamic combat requirements. In addition, CO/FP and SR capabilities, including the force structures and expenditure rates for these forces, must be defined, which will allow the model to calculate the CO/FPR and SRR based on the CPFs generated by the WRMR Model.

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[9] DoDI 8260.01 expands upon the data requirements presented in DoDI 8260.2. DoDI 8260.01 indicates that the baselines are to include a concept of operations, not just order of battle, task organization and equipment, etc. The Components are required to provide current-year concepts of operations and DIA provides non-US concepts of operation. In addition, the data to be provided by DIA has been expanded from "non-US" to "non-US state and non-state actors."

Link: 5.1.2 – Problems with and Commentary on WRMR Model Data (Page 72)

Link: 7.1.2 – Proposed Solutions for WRMR Model Data Discrepancies (Page 103)

4.1.2.1 Time-Phased Force Deployment Data (TPFDD)

The MCCDC ARO currently obtains the most recent TPFDD of record, or other force flow documents, for each of the WD and SD scenarios directly from the supporting MARFORs or MEFs.

Link: 5.1.2.1 – Problems with and Commentary on TPFDDs (Page 72)

Link: 7.1.2.1 – Proposed Solutions for TPFDD Discrepancies (Page 104)

4.1.2.2 Joint Munitions Effectiveness Manuals (JMEM)

The JMEM data elements used in the WRMR model were originally derived in January 2002. Individual data elements are updated every time a new version of JMEM/Surface-To-Surface Weaponeering Effectiveness System (JWES) is released, with the latest updates occurring in the fall of 2007. JWES is a Joint tool for weaponeering that provides probability of kill (Pk) data for shooter-target pairings. Due to the complexity and time-consuming methods necessary to develop JMEM data, not all shooter-target pairings are available. In cases where data values are not available, surrogate values from a similar shooter and target pairing are used.

Occasionally, owing to weapon development and introductions on the part of US, allied and threat forces, JMEM data is not available for a shooter or shooter-target pairing and no suitable surrogate exists. To address these problems, the Joint Technical Coordinating Group / Munitions Effectiveness (JTCG/ME), the organization responsible for developing, maintaining and documenting JMEM data, distributes a request for information to all users of the JMEM products annually. This request allows users to identify shooter-target combinations not currently within the JMEM database to be evaluated and included in future versions. The users may also request relevant modifications and improvements to the JMEM process via this means.

The MCCDC ARO forwards this request for information to the maintainers of the WRMR model, and this staff provides the ARO the highest priority shooter-target pairings not currently represented in the JMEM database. The ARO then electronically forwards this information to the JTCG/ME for consideration. In addition to the questionnaire, the JTCG/ME hosts a semi-annual meeting, usually in the months of April and November, to address these issues.

The methodology to convert JWES Pk output to WRMR model expenditures per kill input is performed differently for direct-fire and indirect-fire weapon systems. For direct-fire weapon systems, the JWES model requires a “burst size” defining the number of rounds in a burst, as well as a “number of bursts” representing the doctrinal number of bursts expended

against a given target type. The default values provided by JWES are generally used for these two data elements. JWES then produces an output table defining the "weighted average" of the probability of kill per expenditure for Mobility-Kills (M-Kills), Firepower-Kills (F-Kills), Mobility/Firepower-Kills (M/F-Kills), and Catastrophic-Kills (K-Kills) for a number of weapon ranges. The weighted average value for M/F-Kills for the range representing approximately 70-80% of the maximum range of the weapon system is then used in the following formula to determine the expenditures per kill to be input into the WRMR model:

```
Expenditures Per Kill = (Burst Size * Number of Bursts) /
(Pk/Expenditure)
```

The probability that a target is hit by this weapon system is repairable is calculated via the following formula:

```
Probability of Repair = (M/F-Kill Pk – K-Kill Pk) / (M/F-Kill Pk)
```

Each of these Pk values is obtained from the aforementioned JWES output table.

For example, suppose weapon system X is used against target type Y and fires a single burst of 10 rounds at a range of 1,000 meters (70% of weapon system X's maximum effective range) and JWES determines the following weighted averages for probability of kills per expenditure:

```
M-Kill – 0.5

F-Kill – 0.4

M/F-Kill – 0.4

K-Kill – 0.2
```

Thus, the expenditures per kill that would be used as input into the WRMR model would be:

```
Expenditures / Kill = (10 * 1) / 0.4 = 25
```

The probability that Y would be repairable given it was struck by weapon system X is:

```
Probability of Repair = (0.4 – 0.2) / 0.4 = 0.5
```

It should be noted that JWES does provide an output called "Average Number of Rounds to Kill" for direct-fire weapon systems that does not provide the same results as the calculation above.

JWES assumes indirect-fire systems target an area instead of a specific enemy weapon system. This methodology requires a fire mission data element representing the percent of desired damage for a given target area, and calculates the rounds per target area required to achieve this level of damage. Usually the default value for percent of desired damage provided by JWES is used for this calculation. To convert this output to the number of

expenditures per kill, as required by the WRMR model, the number of rounds per target area to reach the desired level of damage generated by JMEM is divided by the number of targets per target area. This scaling is required to account for target density and the fact that a specific weapon in the area is not being targeted.

```
Expenditures / Kill = (Rounds per Target Area) / (Targets per Target
Area)
```

The probability an enemy system is repairable is calculated as:

```
Probability of Repair = 1 – (% of desired damage for a given target
area)
```

Link: 5.1.2.2 – Problems with and Commentary on JMEM Input (Page73)

Link: 7.1.2.2 – Proposed Solutions for JMEM Input Discrepancies (Page 104)

4.1.2.3 Subject Matter Expert (SME) Input

The WRMR model requires a significant amount of data to be generated based on military judgment. These input requirements are fully described in the discussions pertaining to the current methodologies used in the WRMR model for target-oriented expenditures and the 13 other add-ons that comprise the total combat requirement (see sections 4.2.1.1 through 4.2.1.14). The model also has additional inputs that have an indirect but significant impact on the results generated, such as the probability a damaged enemy weapon system is recoverable, the probability a weapon system will be required to perform an operational check, and the percentage of weapon systems that should be included in the assault/sustain target sets by posture that are found in the *param.in* file or that are hard-coded within the model.

The SME-supplied inputs trace their origins in the Marine Corps Ammunition Requirements Management System (MCARMS) database, the predecessor to the WRMR model. The WRMR Model V&V Study determined that SME input data validation was completed in December 2004. These data were subsequently reviewed and re-validated in June 2006 as part of the WRMR Model V&V Study. The data is organized into a binder maintained by the Ammunition Branch, Logistics Integration Division.

Link: 5.1.2.3 – Problems with and Commentary on SME Input (Page73)

Link: 7.1.2.3 – Proposed Solutions for SME Input Discrepancies (Page 105)

4.1.2.4 Operations Plan (OPLAN) Alignment

The MRP to support the POM-10 process marked the first time an effort was made to align the battle phases in the WRMR model with the COCOM's anticipated schemes of maneuver and timing of operations. The MCCDC ARO requested assistance in determining the battle phase durations and postures from Marine Forces Pacific (MARFORPAC) and Marine

Forces Central (MARFORCENT) for the WD and SD scenarios. These changes were reviewed again by MARFORPAC to ensure accuracy. MARFORCENT's submission was directly entered into the WRMR model database.

Link: 5.1.2.4 – Problems with and Commentary on OPLAN Alignment (Page 74)

Link: 7.1.2.4 – Proposed Solutions for OPLAN Alignment Discrepancies (Page 106)

4.1.2.5 Determine Current Operations/Forward Presence (CO/FP) Capability

Per MCO 8000.7, the DC, PP&O and the Office of Combat Development and Integration (CD&I) are designated to define the forces and requirements associated with the CO/FP, ensuring that the forces defined comply with the SPG, CPG, and USD (AT&L) Implementation Guidance. PP&O generated the previous CO/FP elements in support of the POM-06 process and has periodically reviewed, but hasn't altered, them. The table below defines the current forces and requirements associated with the CO/FPR as well as the combat planning factors used to generate their munitions requirements.

Component	Composition	Requirement
LFORM[10]	5 notional MEU-sized forces	1 combat load + SOC[11] allowance + 15 days assault rate[12]
ACM[13]	3 notional infantry battalions	1 combat load + 5 days assault rate

Table 4-1: Current Operation / Forward Presence Elements.

Link: 5.1.2.5 – Problems with and Commentary on Determining CO/FP Capability (Page 74)

Link: 7.1.2.5 – Proposed Solutions for Determining CO/FP Capability Discrepancies (Page 106)

4.1.2.6 Determine Strategic Readiness (SR) Capability

As with the CO/FP, the SR capability is determined by PP&O and CD&I. Again, the current forces and requirements were developed prior to the POM-06 process. The only change that has occurred was the removal of the Title 10 treaty obligation known as Marine Forces Europe War Reserve Stock – Israel (MFE WRS-I) which is no longer supported.

---

[10] LFORM – Land Force Operational Reserve Material

[11] SOC – Special Operations Capable

[12] Assault and sustained rates are daily expenditure rates for munitions generated by the WRMR Model and published as combat planning factors.

[13] ACM – Air Contingency Marine Air-Ground Task Force (MAGTF)

Currently, the SR is defined as the forces and ammunition required to support Homeland Defense, Global War on Terror (GWOT), the Unit Deployment Program (UDP), and treaty obligations. Table 4-2 below describes the forces represented by each of these categories, as well as the combat planning factors that are used to generate their munitions requirement.

Component	Composition	Requirement
Homeland Defense	3 notional infantry battalions	1 combat load + 30 days sustained rate
GWOT	3 notional anti-terrorist teams, currently based on that of the 4th MEB (AT)	1 combat load + 3 days assault rate + 15 days sustained rate
UDP	1 infantry battalion, 1 artillery battalion, 1 AAV company, and 1 LAR company, all notional	1 combat load
Title 10 Treaty Obligations	Marine Corps Pre-Position – Norway (MCPP-N)	1 combat load + 30 days assault rate

Table 4-2: Strategic Readiness Elements

Link: 5.1.2.6 – Problems with and Commentary on Determining SR Capability (Page 75)

Link: 7.1.2.6 – Proposed Solutions for Determining SR Capability (Page 107)

4.2 Phase II - Development of TMR

Once all the DoD-led data, PP&O-led OPLAN alignment, and other relevant data elements are validated and entered into the WRMR model database, MCCDC generates the CR, CO/FPR and SRR. These are then combined with the testing requirements compiled and provided by MARCORSYSCOM and the training requirements calculated by TECOM to develop near-year constrained and unconstrained and out-year unconstrained TMRs, which are submitted to DoD.

4.2.1 Compute Combat Requirements

The WRMR model calculates the total combat requirement, or TCR, as the sum of target-oriented munition expenditures and 13 ‘add-ons’, which account for munitions and other items, such as fuses, not expended directly against targets defined in the PTD. These 13 add-ons include illumination and obscuration, rear-area security, self-defense, operational checks, registration, logistical losses, demolition, mining, zeroing, screening, command and control, explosive ordnance disposal (EOD), and ancillary items.

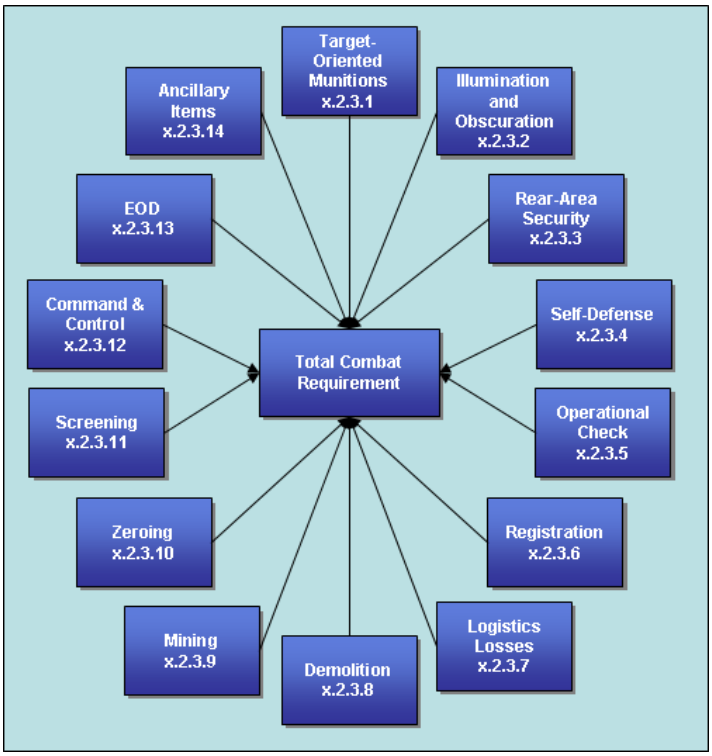

Figure 4-3: Composition of Total Combat Requirement

4.2.1.1 Target-Oriented Munitions Expenditures

The WRMR model uses the target sets as defined in the PTD. Weapon-round combinations are assigned to targets based on user-defined preferences in conjunction with weapon-round availability as driven by the TPFDDs. The WRMR model may adjust this allocation to avoid violating realistic limits on target-weapon engagements imposed by the mix of targets and shooters in the theater, and to prevent daily expenditures in excess of a combat load[14]. Munitions expenditures are calculated on a daily basis to account for changes in phase, target set and availability and posture of forces. The sum of the daily expenditures over the campaign provides the total target-oriented requirement.

The PTD defines the number of targets that must be destroyed during a given phase of the conflict. In an effort to produce combat planning factors for two levels of combat intensity, as is required to support MCBul 8010.1E, the WRMR model does not distribute these targets evenly over all days of a campaign. The model breaks a phase's target set into two 'clusters.' One cluster represents the targets to destroy in high-intensity combat (a user-defined value by phase, usually set to 80%). All remaining targets are placed in a low-

[14] Combat load, or basic load is defined in Joint Publication 1-02 as the quantity of supplies required to be on hand within, and which can be moved by, a unit or formation. It is expressed according to the wartime organization of the unit or formation and maintained at the prescribed levels. (reference JP 1-02)

intensity cluster. The user can then assign the high-intensity cluster to the beginning or end of a phase. The model will attrit high-intensity targets as quickly as possible within constraints, such as daily firing rates. The low-intensity targets are evenly distributed over the remaining days of combat within the phase. Various factors, such as repairs of enemy equipment re-entering the conflict, may prevent all targets on a given low-intensity day from being attrited. In this case, the targets that aren't killed are shifted to the next day. When this occurs on the last day of a phase, the phase is extended as necessary until each of the targets as defined in the PTD has been destroyed.

The available shooters for any given day are determined by the TPFDD as well as the posture of the Marine forces. The posture indicates the percentage of ground combat element (GCE) forces in theater that are engaged. For each day of the scenario, the WRMR model allocates the available shooters to targets. This allocation is based on a collection of user-defined input percentages identifying the preferred weapon and munition combinations to be used against each enemy weapon type. The allocations are, by definition, provided without regard to the composition of the Marine forces in theater on a given day.

The allocations provided may be adjusted by the WRMR model on a daily basis to avoid exceeding daily expenditure rates and to ensure that a credible weapon-to-target allocation, as well as munition-to-target allocation, is produced. It does this by first assuming that all available targets are to be killed and determining the ammunition expenditures for all shooter types (weapon-round combinations) based solely on the allocations the user provided. The list of all weapon-round combinations are then sorted based on the ratio of these desired expenditures to the corresponding maximum daily expenditure limits. This sorted list is then stratified into four groups.

The first group consists of weapon-munition combinations in which the desired expenditures exceed the maximum daily expenditures of the given weapon-munition combination. If more than 30% of all weapon-munition combination fall into this category, only the top 30% of shooter types will be placed in this category. These weapon-munition combinations have their allocation scaled to their maximum daily expenditure rate. Note that the maximum daily expenditure rate is calculated as the shooter type's combat load minus certain recurring combat-oriented "overhead" expenditures, such as registration, zeroing, and operational checks.

The second group has each of its members scaled down proportionally to the least busy shooter type in the first group, while maintaining a minimum final expenditure rate equal to or greater than 15% of its maximum expenditure rate.

The third group has its target allocations scaled down by progressively smaller degrees so that their daily expenditure rates end up equal to their minimum expenditure threshold (15% of its maximum expenditure rate).

The fourth group consists of shooter types in which the desired expenditures is less than the maximum daily expenditure rate. In this case, no scaling is required.

Example: Figure 4-4 below depicts a hypothetical collection of 10 notional shooter types that have been sorted according to their ratios of desired to maximum expenditures and then stratified into four groups. The top three shooter types form the first group, and they are scaled so that their scaled expenditures equal their maximum expenditures. The next three shooter types form the second group, and they receive the same scaling factor as the third shooter type. This group includes all shooter types that do not belong to the first group and for which applying the same scaling factor as the third shooter type yields scaled expenditures that exceed 15% of maximum. The next three shooter types form the third group, and they are scaled so that their scaled expenditures equal 15% of maximum. This group includes all shooter types that do not belong to the top two groups and for which the ratio of desired to maximum expenditures exceeds 0.15 (so that it is possible to scale the desired expenditures down to 15% of maximum). All other shooter types belong to the fourth group, and they receive no scaling.

Weapon/Round Combination	Desired Expenditures	Maximum Expenditures	Desired ÷ Maximum	Scaling Factor	Scaled Expenditures	Percentage of Maximum Expended	
1	100,000	1,000	100	0.01	1,000	100%	First Group (top 30%)
2	5,000	100	50	0.02	100	100%	
3	50,000	2,000	25	0.04	2,000	100%	
4	15,000	1,500	10	0.04	600	40%	Second Group
5	5,000	1,000	5	0.04	200	20%	
6	10,000	2,500	4	0.04	400	16%	
7	6,000	2,000	3	0.05	300	15%	Third Group
8	20,000	20,000	1	0.15	3,000	15%	
9	5,000	10,000	0.5	0.3	1,500	15%	
10	500	10,000	0.05	1	500	5%	Fourth Group

Figure 4-4: Hypothetical Target-Oriented Expenditure Calculation

The expected number of rounds to kill a single target is provided as input, which is obtained from JWES. In cases where a shooter-target value is not available in JWES a surrogate is used.

The expenditure-per-kill values provided by JMEM only account for destructive fires against real targets, and do not account for expenditures against false targets or expenditures used for suppressive fires. Thus, the WRMR model allows the user to enter a false target expenditure ratio by shooter type, which uses the following formula to adjust the average expenditures per kill for destructive fires:

$$\begin{pmatrix}\text{Average expenditure per kill}\\ \text{for destructive fires}\end{pmatrix} = \begin{pmatrix}\text{expenditure per kill}\\ \text{(input)}\end{pmatrix} \times (1 + \text{false expenditure ratio})$$

Suppressive fires are calculated for fires against mortars, towed howitzers, towed anti-tank weapons, field fortification, towed air defense guns, and personnel, including anti-tank guided missiles and man-portable air defense systems. The average expenditure per kill for suppressive fires is calculated using the following formula for shooter types designated by the user as having the ability to provide suppressive fires:

$$\begin{pmatrix}\text{Average expenditure per kill}\\ \text{for suppressive fires}\end{pmatrix} = \begin{pmatrix}\text{expenditure per kill}\\ \text{(input)}\end{pmatrix} \times 100$$

When suppressive fires are applicable, they are assumed to achieve $1/10^{th}$ of the number of kills achieved by destructive fires[15], which equates to $1/11^{th}$ of the total kills. This $1/10^{th}$ value is defined, by DODIC, in the *suppress.in* data file and is not hard-coded into the model. Currently, all DODICs in the *suppress.in* data file are assigned this same value. Consequently, when suppressive fires are applicable, the average expenditure per target is computed using the following formula:

$$\begin{pmatrix}\text{Average expenditure}\\ \text{per target killed}\end{pmatrix} = \frac{10}{11}\begin{pmatrix}\text{average expenditure per kill}\\ \text{for destructive fires}\end{pmatrix} + \frac{1}{11}\begin{pmatrix}\text{average expenditure per kill}\\ \text{for suppressive fires}\end{pmatrix}$$

Equipment that is destroyed may be repaired. The WRMR model allows the user to define the probability that a piece of equipment may be available for repair based on posture. This, in essence, defines the probability that the equipment will be recoverable under combat conditions by the enemy. If recoverable, the model applies a probability of repair calculation to determine if the system is repairable, and if so, defines the duration, in days, that the repair will take. The probability of repair and repair duration are obtained from JMEM data where possible, otherwise a surrogate or SME-supplied value is used. After the given repair duration, the weapon system once again becomes a target available for destruction by Marine forces.

$$\begin{matrix}\text{Daily losses}\\ \text{for a weapon}\end{matrix} = \frac{\text{Daily power-rated USMC attritions}}{\text{Daily USMC combat power}}\begin{pmatrix}\text{weapons in}\\ \text{the GCE}\end{pmatrix}$$

Losses and repairs will also affect the number of available Marine Corps weapons for any

[15] The U.S. Army utilizes a similar methodology, with a multiplier being applied to target-oriented expenditures in JICM. The U.S. Army receives the multipliers from TRADOC via DAMO TRA.

given day. Marine Corps losses are calculated as a user-defined proportion of enemy losses on a given day. This calculation is made using a collection of SME-supplied "power ratings" assigned to each USMC weapon expected to kill targets and to each target type to be killed by posture. These power ratings, independently defined for each scenario, represent the relative effectiveness of a given system in comparison to all other systems. They have values ranging from 1 to 100 with 100 being most important (a value of 0 indicates the weapon doesn't fire or get attrited). The analyst must use a scale for enemy weapon systems that is also relative to that used for the USMC weapon systems. Thus, a system with a power rating of 100 would be twice as important as a weapon system with a power rating of 50 in accomplishing Marine Corps attrition goals for a given battle.

For each Marine weapon system that destroys an enemy target on a given day, the following calculations are used to determine the Marine weapon losses:

$$\begin{pmatrix}\text{Daily power-rated}\\ \text{target kills}\end{pmatrix} = \sum_{\text{target}}\left[\begin{pmatrix}\text{daily}\\ \text{target kills}\end{pmatrix}\begin{pmatrix}\text{target}\\ \text{power rating}\end{pmatrix}\right]$$

$$\begin{pmatrix}\text{Daily power-rated}\\ \text{USMC attritions}\end{pmatrix} = \begin{pmatrix}\text{power-rated}\\ \text{target kills}\end{pmatrix}\begin{pmatrix}\text{loss exchange}\\ \text{ratio}\end{pmatrix}$$

$$\begin{pmatrix}\text{Daily USMC}\\ \text{combat power}\end{pmatrix} = \sum_{\text{weapon}}\left[\begin{pmatrix}\text{weapons in}\\ \text{the GCE}\end{pmatrix}\begin{pmatrix}\text{weapon}\\ \text{power rating}\end{pmatrix}\right]$$

Link: 5.2.1.1 – Problems with and Commentary on Target-Oriented Expenditures (Page 75)

Link: 7.2.1.1 – Proposed Solutions for Target-Oriented Deficiencies (Page 108)

4.2.1.2 Illumination and Obscuration Expenditures

In the WRMR model, each weapon system capable of servicing the obscuration/ illumination role has a data value indicating the number of minutes of illumination provided per round. Each weapon system also is assigned a requirement of the number of minutes of obscuration/illumination that must be provided per engaged infantry company per day based upon force posture. The following calculation then determines the daily illumination expenditures:

$$\begin{pmatrix}\text{Daily}\\ \text{illumination}\\ \text{expenditures}\end{pmatrix} = \begin{pmatrix}\text{infantry}^{\dagger}\\ \text{companies}\\ \text{employed}\\ \text{to date}\end{pmatrix}\begin{pmatrix}\text{fraction of}\\ \text{USMC}\\ \text{forces}\\ \text{engaged}\end{pmatrix}\frac{\begin{pmatrix}\text{minutes of illumination}\\ \text{needed}\\ \text{per day per infantry}^{\dagger}\\ \text{company in contact}\end{pmatrix}}{\begin{pmatrix}\text{minutes of illumination}\\ \text{provided per round}\end{pmatrix}}$$

†LAR companies are used when computing expenditures for LAV Mortar.

It is important to note that for the POM-10 submission, the WRMR model was altered to use historical values derived from Operation Iraqi Freedom (OIF) expenditure rates, as suggested by the GAR Study Team. Sections 5.2.1.2 and 7.2.1.2 provide the reason this change was suggested and the methods used to determine the obscuration and illumination expenditure rates relative to anti-personnel/anti-material (AP/AM), respectively.

Link: 5.2.1.2 – Problems with and Commentary on Illumination/Obscuration Expenditures (Page 80)

Link: 7.2.1.2 – Proposed Solutions for Illumination/Obscuration Deficiencies (Page 111)

4.2.1.3 Rear-Area Security Expenditures

The rear-area security expenditure category represents the ammunition fired by non-ground combat elements in defense of their positions. This can be due to enemy special operations forces operating in the rear area, insurgencies, or any other enemy action that affects Combat Service Support, aviation, command, and similar rear-area elements.

In the WRMR model, this requirement is currently derived through the following formula, with the rounds per weapon per day provided by SMEs.

$$\begin{pmatrix}\text{Daily rear-area}\\ \text{security expenditures}\end{pmatrix} = \begin{pmatrix}\text{weapons not belonging}\\ \text{to the GCE}\end{pmatrix}\begin{pmatrix}\text{rounds per weapon}\\ \text{per day}\end{pmatrix}$$

Link: 5.2.1.3 – Problems with and Commentary on Rear-Area Security Expenditures (Page 81)

Link: 7.2.1.3 – Proposed Solutions for Rear-Area Security Deficiencies (Page 116)

4.2.1.4 Self-Defense Expenditures

The self-defense category represents expenditures from the use of sniper rifles, handguns and other small-arms by individuals engaging the enemy at close quarters. It also includes expenditures of tear gas (CS). The WRMR model uses two separate calculations to determine these expenditures. The small arms formula is performed for every applicable weapon type as follows:

$$\begin{pmatrix}\text{Daily self-defense}\\ \text{expenditures}\end{pmatrix}=\begin{pmatrix}\text{weapons in the}\\ \text{USMC force}\end{pmatrix}\begin{pmatrix}\text{rounds per weapon}\\ \text{per day}\end{pmatrix}$$

The formula for the CS expenditures is performed for every applicable weapon type as follows:

$$\begin{pmatrix}\text{Daily self-defense}\\ \text{expenditures}\end{pmatrix}=\begin{pmatrix}\text{infantry}\\ \text{battalions}\end{pmatrix}\left(\frac{\text{combat load}\times 2}{\text{duration of scenario}}\right)$$

The value for the number of rounds per weapon per day in the small arms formula is currently a SME-supplied input that is variable based on the posture of the USMC forces and the round type associated with their weapons mix. The implicit assumption in the CS formula is that each infantry battalion expends two combat loads from CS-capable weapons during the duration of the conflict.

The WRMR model formulas for self-defense expenditures include all forces, GCE and non-GCE, in theater. For the GCE forces, however, the sum of rounds fired against elements of the target set and self-defense cannot exceed the maximum daily expenditure for a given munition.

Link: 5.2.1.4 – Problems with and Commentary on Self-Defense Expenditures (Page 82)

Link: 7.2.1.4 – Proposed Solutions for Self-Defense Deficiencies (Page 117)

4.2.1.5 Operational Check Expenditures

This category represents the munitions expended by individual and crew-served small arms weapons that may be fired by members of the GCE to verify the operational status of their weapons. This activity is frequently performed at first light prior to deployment to daytime objectives and is quantified in the WRMR model with the following formula:

$$\begin{pmatrix}\text{Daily operational}\\ \text{check expenditures}\end{pmatrix}=10\%\times\begin{pmatrix}\text{weapons in}\\ \text{the GCE}\end{pmatrix}\begin{pmatrix}\text{rounds per weapon}\\ \text{per day}\end{pmatrix}$$

The 10% value, derived from SMEs, estimates an operational check is required once every 10 days.

Link: 5.2.1.5 – Problems with and Commentary on Operational Check Expenditures (Page 82)

Link: 7.2.1.5 – Proposed Solutions for Operational Check Deficiencies (Page 118)

4.2.1.6 Registration Expenditures

The registration category accounts for rounds required to adjust fire control calculations when indirect-fire weapons are moved from one place to another in an operational environment. The WRMR model uses two different formulas to calculate registration expenditures. The following is performed for every applicable weapon type as follows for mortars:

$$\begin{pmatrix}\text{Daily registration}\\ \text{expenditures}\end{pmatrix} = \frac{\begin{pmatrix}\text{weapons in}\\ \text{the GCE}\end{pmatrix}\begin{pmatrix}\text{fraction of weapons}\\ \text{registered per day}\end{pmatrix}}{\text{weapons per registration}}\begin{pmatrix}\text{rounds expended}\\ \text{per registration}\end{pmatrix}$$

The formula below is for howitzers:

$$\begin{pmatrix}\text{Daily registration}\\ \text{expenditures}\end{pmatrix} = \frac{\begin{matrix}\text{GCE weapons}\\ \text{newly arriving}\end{matrix} + \begin{matrix}\text{weapons returning}\\ \text{from repair}\end{matrix}}{\text{weapons per registration}}\begin{pmatrix}\text{rounds expended}\\ \text{per registration}\end{pmatrix}$$

In both of these formulas, the number of weapons of a given type that are registered as well as the rounds expended per registration are currently a SME-supplied input, as is the fraction of weapons of a given type that are registered per day for the mortar calculation.

Link: 5.2.1.6 – Problems with and Commentary on Registration Expenditures (Page 82)

Link: 7.2.1.6 – Proposed Solutions for Registration Deficiencies (Page 118)

4.2.1.7 Logistics Losses

The WRMR model accounts for daily rounds lost in the replenishment pipeline through accident or enemy activity using the formula below:

The formula for calculating daily logistics losses is as follows:

Daily logistics losses = (Daily Expenditures)(Fraction of Stocks Lost / (1 – Fraction of Stocks Lost))

The fraction of stocks lost is a SME-supplied input for each munition type. This formula assumes that the quantity of munitions in the daily replenishment pipeline is equal to the daily expenditures of the given munition. This formula also ensures that the quantity of munitions in the replenishment pipeline is sufficient to satisfy the replenishment demand as well as account for logistical losses.

Link: 5.2.1.7 – Problems with and Commentary on Logistics Losses (Page 83)

Link: 7.2.1.7 – Proposed Solutions for Logistics Losses (Page 119)

4.2.1.8 Demolition Expenditures

This category represents the munitions employed in combat engineering actions during both defensive and offensive combat operations. When on the defense, demolition teams may be used to channel the attacking enemy or to slow their advance, aid in flank protection, or to deny the enemy maneuver space. During offensive operations obstacles must be breached in an effort to clear fields of fire, maintain supply routes, and provide for internal communications of all types.

In the WRMR model, the total daily demolition requirement is the sum of the expenditures required for creating obstacles and the expenditures required to destroy obstacles, where each value is individually calculated via the following formula:

$$\begin{pmatrix}\text{Daily demolition}\\ \text{expenditures for}\\ \text{creating/breaching obstacles}\end{pmatrix}=\begin{pmatrix}\text{infantry companies}\\ \text{employed to date}\end{pmatrix}\begin{pmatrix}\text{fraction of USMC}\\ \text{forces engaged}\end{pmatrix}\begin{pmatrix}\text{obstacles created/breached}\\ \text{per infantry company}\\ \text{in contact per day}\end{pmatrix}\begin{pmatrix}\text{rounds per obstacle}\\ \text{created/breached}\end{pmatrix}$$

The number of employed infantry companies in contact on a given day is determined by the force flow and the fraction of forces engaged is based on the posture of forces as determined by the OPLAN alignment with the WRMR model input. The number of obstacles created or breached per day per infantry company, as well as the number of rounds expended per obstacle, are SME-supplied inputs.

Link: 5.2.1.8 – Problems with and Commentary on Demolition Expenditures (Page 84)

Link: 7.2.1.8 – Proposed Solutions for Demolition Deficiencies (Page 119)

4.2.1.9 Mining Expenditures

Mines may be employed in offensive operations to aid in flank protection, to reduce the enemy's ability to maneuver forces to the point of attack, or to interdict interior lines of communication. In defensive operations, mines may be used to disrupt, channel, or slow enemy formations.

The WRMR model calculates mine expenditures as follows:

$$\begin{pmatrix}\text{Daily mine}\\ \text{expenditures}\end{pmatrix}=\begin{pmatrix}\text{infantry companies}\\ \text{employed to date}\end{pmatrix}\begin{pmatrix}\text{fraction of USMC}\\ \text{forces engaged}\end{pmatrix}\begin{pmatrix}\text{rounds per infantry}\\ \text{company in contact per day}\end{pmatrix}$$

The number of infantry companies in contact on a given day is based upon the force flow, and the fraction of engaged forces is based on the posture of the Marine forces on the given day. The rounds per infantry company in contact per day value is a SME-supplied input.

Link: 5.2.1.9 – Problems with and Commentary on Mining Expenditures (Page 84)

Link: 7.2.1.9 – Proposed Solutions for Mining Deficiencies (Page 119)

4.2.1.10 Zeroing Expenditures

This category represents the number of rounds expended to establish the battle-sight accuracy of a weapon. Each weapon type that requires zeroing is provided with a SME-determined number of rounds for that purpose. Weapons are zeroed upon arrival in-theater, based upon the force flow, as well as when a damaged weapon returns following repair. The formula for calculating daily zeroing expenditures by weapon system is as follows:

$$\begin{pmatrix}\text{Daily zeroing}\\ \text{expenditures}\end{pmatrix} = \left[\begin{pmatrix}\text{weapons arrived}\\ \text{in theater}\end{pmatrix} + \begin{pmatrix}\text{weapons}\\ \text{repaired}\end{pmatrix}\right]\begin{pmatrix}\text{rounds to zero}\\ \text{a weapon}\end{pmatrix}$$

Link: 5.2.1.10 – Problems with and Commentary on Zeroing Expenditures (Page 84)

Link: 7.2.1.10 – Proposed Solutions for Zeroing Deficiencies (Page 119)

4.2.1.11 Screening Expenditures

Many combat vehicles are equipped with screening-smoke grenade launchers to provide concealment during evasive or other maneuvers or protection from enemy weapons system detection. The WRMR model uses SME estimates for screening episodes per vehicle per day and rounds per episode in the formula below to calculate this requirement:

$$\begin{pmatrix}\text{Daily screening}\\ \text{expenditures}\end{pmatrix} = \begin{pmatrix}\text{vehicles in}\\ \text{the GCE}\end{pmatrix}\begin{pmatrix}\text{screening episodes per}\\ \text{vehicle per day}\end{pmatrix}\begin{pmatrix}\text{rounds per}\\ \text{episode}\end{pmatrix}$$

The number of vehicles in the GCE is based on force flow, while the screening episodes per vehicle per day and rounds per episode are SME-supplied inputs.

Link: 5.2.1.11 – Problems with and Commentary on Screening Expenditures (Page 84)

Link: 7.2.1.11 – Proposed Solutions for Screening Deficiencies (Page120)

4.2.1.12 Command & Control Expenditures

The command and control category involves pyrotechnic rounds expended to signal operational phase changes, provide warning of opposing force movements, mark positions, etc. The frequency of their use will vary depending upon the intensity of engagements, the degree of secrecy desired for a type of operation, and the degree of control or complexity of the operations.

The number of command and control rounds expended per day per USMC company in contact is presently a SME-supplied input that depends on the posture of the USMC force. For the E0949 Light Amphibious Vehicle (LAV) mortar, these rates are specified per

USMC Light Armored Reconnaissance (LAR) company in contact. For all other weapon systems, these rates are specified per USMC infantry company in contact.

The formula for calculating daily command and control expenditures is as follows:

$$\begin{pmatrix}\text{Daily command}\\ \text{and control}\\ \text{expenditures}\end{pmatrix}=\begin{pmatrix}\text{infantry}^{\dagger}\ \text{companies}\\ \text{employed to date}\end{pmatrix}\begin{pmatrix}\text{fraction of USMC}\\ \text{forces engaged}\end{pmatrix}\begin{pmatrix}\text{rounds per}\\ \text{infantry}^{\dagger}\ \text{company}\\ \text{in contact per day}\end{pmatrix}$$

† number of LAR companies are used when computing expenditures for LAV mortar

The number of infantry or LAR companies employed to date is determined by the force flow, and the fraction of USMC forces engaged is determined by the OPLAN alignment within the WRMR model. The rounds per infantry/LAR company in contact per day is a SME-supplied input.

Link: 5.2.1.12 – Problems with and Commentary on Command & Control Expenditures (Page 85)

Link: 7.2.1.12 – Proposed Solutions for Command & Control Deficiencies (Page 120)

4.2.1.13 Explosive Ordnance Disposal (EOD) Expenditures

EOD teams render safe or destroy unexploded munitions during large-scale operations such as airfield recovery, forward arming and refueling, area clearance throughout the operational area both during and after combat, and destruction of enemy ammunition caches and supply points. EOD teams also perform smaller-scale operations such as improvised explosive device (IED) and unexploded ordnance render-safe procedure and standoff disruption of firing devices and munitions. The WRMR model currently calculates daily EOD requirements as the sum of the large-scale and small-scale requirements, each of which has a separate formula. The formula for large-scale daily expenditures is defined as:

$$\begin{pmatrix}\text{Daily EOD}\\ \text{expenditures}\end{pmatrix}=\left(\frac{\text{number of large-scale EOD operations in scenario}}{\text{duration of scenario}}\right)\begin{pmatrix}\text{rounds per}\\ \text{EOD operation}\end{pmatrix}$$

The formula for small-scale expenditures is defined as:

$$\begin{pmatrix}\text{Daily EOD}\\ \text{expenditures}\end{pmatrix}=\begin{pmatrix}\text{EOD teams in}\\ \text{the USMC force}\end{pmatrix}\begin{pmatrix}\text{number of smaller-scale EOD}\\ \text{operations per EOD team per day}\end{pmatrix}\begin{pmatrix}\text{rounds per}\\ \text{EOD operation}\end{pmatrix}$$

The number of large- and small-scale operations per scenario, as well as the rounds per EOD operation, is a SME-supplied input.

Link: 5.2.1.13 – Problems with and Commentary on EOD Expenditures (Page 85)

Link: 7.2.1.13 – Proposed Solutions for EOD Deficiencies (Page 120)

4.2.1.14 Ancillary Item Expenditures

Ancillary items are components, such as howitzer propellant charges, that are expended whenever a primary ammunition type is expended. SME input determines the ancillary-to-primary expenditure ratio. This multiplier is applied to the primary expenditures to determine ancillary expenditures.

Link: 5.2.1.14 – Problems with and Commentary on Ancillary Item Expenditures (Page 85)

Link: 7.2.1.14 – Proposed Solutions for Ancillary Item Deficiencies (Page 121)

4.2.2 Determine Combat Planning Factors

The WRMR model generates two sets of CPFs, an 'assault rate' which represents the expected daily expenditure rate during high-intensity combat, and a 'sustained rate' representing expected daily expenditures during all other intensity levels. These CPFs are used for two separate purposes. First, the CPFs are applied to CO/FP and SR forces to generate the CO/FPR and SRR portions of the TMR (see section 4.2.3). Second, these CPFs are published for use by the Marine logistics schools, operational planners, and ammunition officers. Section 8 of this report provides insight to the validity of these factors and how planners and ammunition officers apply these numbers.

To calculate CPFs for each weapon/round combination (referred to as "shooter type"), the model ranks the average daily expenditures from highest to lowest. It is important to note that this is done for each shooter type as on any given day it is possible for one shooter type to have a heavy expenditure while another shooter type has a lighter expenditure due to the targets engaged on the particular day. Also, this ranked list is a comprehensive list encompassing all the days of expenditures from all the scenarios represented in the WRMR model database, including SD scenarios (for each fiscal year separately). This allows the results from multiple scenarios with potentially very different daily profiles of expenditures per shooter to be taken into account without presuming that any one scenario necessarily includes both high-intensity days and low-intensity days for each shooter type.

Once the ordered list of days has been created the WRMR model makes two simple checks. In the case of a constant expenditure rate across all days this becomes the assault and the sustained rate. If more than half the days have a zero expenditure rate, then the sustained rate is set to zero and the assault rate is defined as the average of the expenditure rates of all non-zero days. If the data does not support either of these simple cases, the model creates two bins, one to hold the days representing the highest expenditures and another to contain

the days with the lowest expenditures.

Starting from the days of the highest expenditure, the high-intensity bin will first include all days with expenditures equaling the highest expenditure day. Days will continue to be added until the high-intensity bin contains at least 20% of all days represented in the data set and until the high-intensity bin contains all the days with expenditures within one 'expenditure band' of the maximum expenditure. An expenditure band is defined as 10% of the difference between the maximum and minimum daily expenditure.

Starting from the days of the lowest expenditure, the low-intensity bin will first include all days with expenditures equaling the lowest expenditure day. Days will continue to be added until the low-intensity bin contains at least 20% of all days represented in the data set and until the low-intensity bin contains all the days with expenditures within one expenditure band of the minimum expenditure.

If more than 10% of all days are not placed in the high- or low-intensity bins, the day with the lowest expenditure rate not currently in a bin will have its expenditure rate compared with the closest expenditure rate in both the high- and low-intensity bins. If it is closer to the expenditure rate in the low-intensity bin this day is placed in the low-intensity bin, otherwise the day with the highest expenditure rate not currently in a bin is placed in the high-intensity bin. This process is continued until no more than 10% of all days are outside the bins.

The average of the expenditure rates for all days in the high-intensity bin is then defined as the assault rate CPF, and the average of expenditure rates for all days in the low-intensity bin is the sustain rate CPF.

Example: The accompanying graph depicts a profile of 120 sorted daily data points. Since very few of the points are the same as the maximum or minimum daily expenditures, this does not determine a grouping of many points into either the high- or low-intensity category, thus the model categorizes the leftmost and rightmost 24 points (or 20% of all the data points) into the high- and low-intensities, respectively. Since both the high- and the low-intensity categories contain all bands within one expenditure rate band, no additional points are added due to this cause. Likewise, since no days have the same expenditure rate as the lowest value in the high-intensity category, or the highest value in the low-intensity category, no additional points are added to either category. The next step is to "walk" the data between these categories, adding them to either the high- or low-intensity bin. It should be clear from the graph that the differences between adjacent points at the right-hand boundary of the range of not-yet-categorized points tend to be smaller than the differences at the left-hand boundary, so the low-intensity category will expand (leftward) to reach the flat "plateau" in the middle of the graph before the high-intensity category does. Once it does, it will expand across that plateau until the number of uncategorized points is less than 10% of the total (in this case, 11 out of 120). In this particular example, the high-intensity, or assault, rate is approximately 6.0 rounds per day, and the low-intensity, or sustained, rate is approximately 2.5 rounds per day.

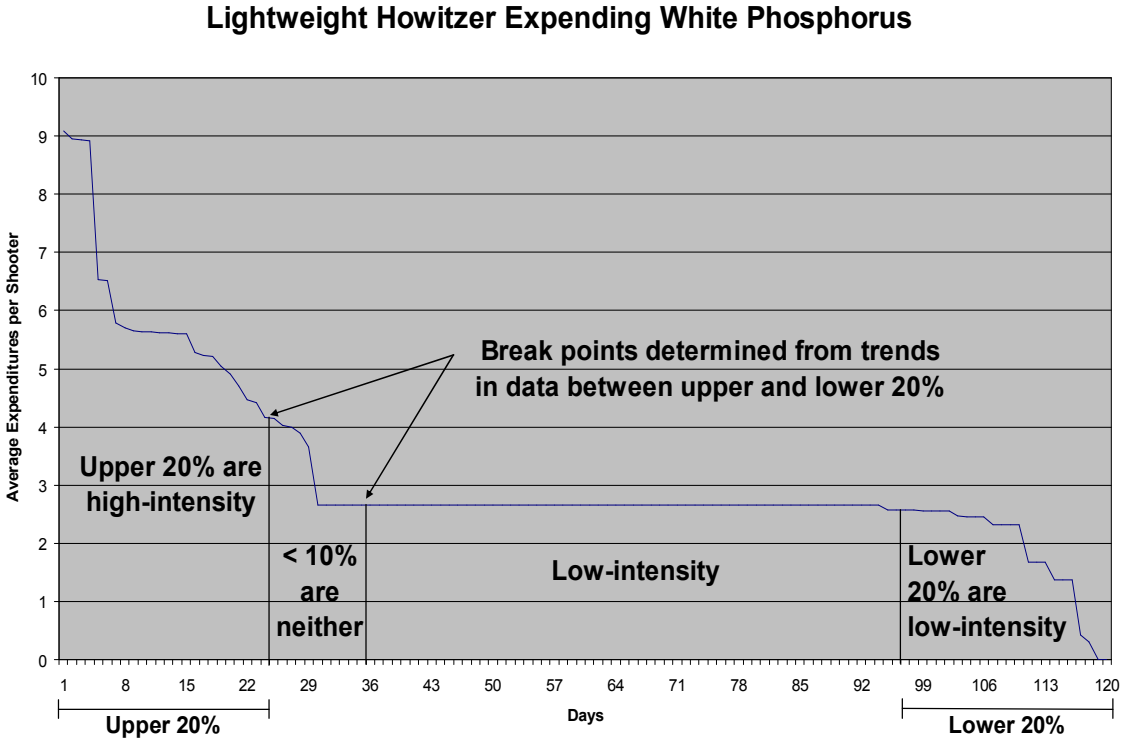

Figure 4-5: Notional Ranked Daily Expenditures Used for CPF Calculations

Link: 5.2.2 – Problems with and Commentary on Determining Combat Planning Factors (Page 85)

Link: 7.2.2 – Proposed Solutions for Determining Combat Planning Factors Deficiencies (Page 121)

4.2.3 Compute CO/FPR and SRR

The WRMR model utilizes the assault and sustained rate CFPs generated as a byproduct of the calculation of the combat requirements to determine the CO/FPR and SRR. For every DODIC, the assault/sustained rate is multiplied by the number of weapons in the given CO/FP or SR force structure to determine a daily assault/sustained expenditure rate. This daily rate is then multiplied by the number of days of assault/sustained fire provided by PP&O for the given CO/FP or SR requirement.

Link: 5.2.3 – Problems with and Commentary on Computing CO/FPR and SRR (Page 86)

Link: 7.2.3 – Proposed Solutions for Computing CO/FPR and SRR Deficiencies (Page 121)

4.2.4 Determine Training Requirement

The total training requirement currently submitted as part of the TMR consists of three separate components. These include the Marine Corps training requirements as calculated

by the Training and Education Command (TECOM), the Title 10 requirements representing ammunition provided by the Marine Corps to allied nations during select international exercises as determined by the MARFORs, and a peacetime pipeline (PPL) determined by MARCORSYSCOM which ensures that sufficient ammunition is being manufactured to avoid shortfalls in training ammunition, especially during transition to a new fiscal year. These requirements are calculated annually and submitted to the MCCDC ARO in the September/October timeframe.

TECOM prepares the annual training ammunition requirement by the end of June and submits it to MCCDC in the September/October timeframe. MCCDC then combines these training requirements with the results of the WRMR model to determine the total munitions requirement (TMR), which is then submitted to the MARCORSYSCOM. MARCORSYSCOM turns the TMR into an Approved Acquisition Objective (AAO) and requests funding from the P&R Department, Headquarters Marine Corps (HQMC). P&R analyzes all USMC-wide AAOs and determines MARCORSYSCOM's funding levels which, in turn, influence TMR funding. In cases where funding and inventory levels are insufficient to support training requirements, the AWG meets to discuss and recommend solutions to the given supportability problem. AWG-recommended changes in training ammunition allowances are then entered in Training Ammunition Management Information System – Redesigned (TAMIS-R) by TECOM and are, therefore, reflected in future annual requirements estimates.

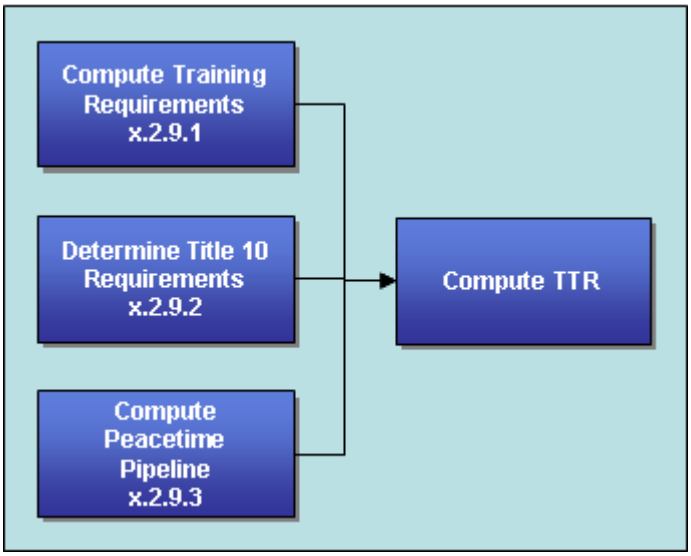

Figure 4-6: Composition of Total Training Requirement

4.2.4.1 Compute Training Requirements

TECOM Order (TECOMO) 8011.1, signed 12 September 2007, defines the current process for determining training ammunition requirements. This order states that training ammunition allowances are established by TECOM based upon requirements provided by users and validated annually, and published in MCBul 8011. Furthermore, training

ammunition allowances and expenditures are recorded and tracked in the TAMIS-R, a software package first used by the Marine Corps in 2004.

TECOMO 8011.1 defines the total training ammunition requirement as being composed of five sources:

Entry-level training, formal schools, and formal courses. These ammunition requirements are generated from each institution's detailed programs-of-instruction (POI) based on tasks published in the current Training and Readiness (T&R) manuals. The procedure for calculating these requirements is straightforward:

(# of rounds per student) x (# of students per class) x (number of classes per year)

Marksmanship / Common skills training for all Marines. Similar to the entry-level training formula, this requirement is derived by simply multiplying the number of Marines required to perform the training per year by the number of rounds required to complete the training.

This also provides an accurate annual ammunition requirement as the rounds per Marine are defined in MCO 1510.89B, *Individual Training Standards (ITS) System for Marine Corps Common Skills (MCCS)*, Volume I, and MCO 3574.2K, *Marine Corps Combat Marksmanship Programs*, and can traceably fluctuate as the Marine force structure and training requirements change.

Exercise support. Exercise planners calculate ammunition requirements by multiplying an aggregate exercise requirement by the number of units to participate in the given exercise. These numbers may in reality fluctuate based upon the specific training objectives of each commander, but the baseline number provides a reasonable value for determining future requirements.

It is important to note that this category of exercise support does not encompass all exercises performed by the Marine Corps. Ammunition requirements associated with units participating in international exercises, such as Cobra Gold and Ulchi Freedom Guardian, are defined as sustainment training.

Previously established allowances and other expenditures. This category includes such things as competition-in-arms programs, squad competition, explosive ordnance disposal (EOD), military police (MP), and game warden operational ammunition. These requirements are based on historical allowances.

Sustainment training. TECOMO 8011.1 indicates that this value is defined as the total training requirements, as defined in MCBul 8011, minus the sum of the other previous categories. The fact that the MCBul 8011 baseline is based upon these five inputs, however, indicates that this cannot be the case. Instead, sustainment is primarily based on the previous year's sustainment allowances. Thus, it should theoretically be traceable directly to the FY00 baseline defined by the '98 Ground Training Ammunition Review Group (GTARG). Unfortunately, as the 2006 NAS audit indicated, the cumulative impact of changes in force structure and training requirements occurring over the past seven years has

not been well documented, thus it is difficult to correlate the current sustainment requirement with the FY00 baseline.

Link: 5.2.4.1 – Problems with and Commentary on Computing Training Requirements (Page 86)

Link: 7.2.4.1 – Proposed Solutions for Computing Training Requirements Deficiencies (Page 121)

4.2.4.2 Determine Title 10 Requirements

Per section 2010 of the United States Code, the Secretary of Defense is authorized to pay the incremental expenses of a developing country, including the provision of training ammunition, that are incurred as the direct result of participation in a bilateral or multilateral military exercise. (United States Code, 2007) The POM-10 TMR included these Title 10 training munitions for the first time. The MARFORs generate these requirements from historical data and provide them directly to the MCCDC ARO, who adds them to the TECOM TTR.

Link: 5.2.4.2 – Problems with and Commentary on Determining Title 10 Requirements (Page 88)

Link: 7.2.4.2 – Proposed Solutions for Determining Title 10 Requirements Deficiencies (Page 127)

4.2.4.3 Compute Peacetime Pipeline (PPL) Requirements

The PPL is a quantity of munitions added to the training-specific munition requirements provided by TECOM to MCCDC. It represents the estimated number of munitions that have been purchased but not yet delivered to the end users at any given time. Per a letter from the Commander of MARCORSYSCOM dated 8 June 2007, the PPL guidance is derived from CMC letter 8000/R dated 9 June 1997 and is defined as 313 days of training ammunition, which "is the weighted average time required to deliver ammunition to Marine forces in support of training requirements."

Link: 5.2.4.3 – Problems with and Commentary on Computing Peacetime Pipeline Requirements (Page 88)

Link: 7.2.4.3 – Proposed Solutions for Computing Peacetime Pipeline Requirements Deficiencies (Page 128)

4.2.5 Determine Testing Requirement

Per Acquisition Policy Letter (APL) 1-07, signed 20 July 2007, the Program Manager for Ammunition (PM Ammo) from MARCORSYSCOM "is responsible for effective acquisition and sustainment throughout the munitions lifecycle." This letter provides the guidance to PM Ammo to support the requirement defined in MCO 8000.7 for

MARCORSYSCOM to provide forecasted testing requirements to MCCDC for inclusion into the TMR.

By 1 August each year, PM Ammo generates a request to the munition program managers throughout the Marine Corps to provide an updated testing requirement. The PMs are required by APL 1-07 to provide this information to PM Ammo by 1 September each year. PM Ammo combines each of these requirements to determine the total testing requirement, and submits this information to MCCDC to be incorporated into the TMR.

Link: 5.2.5 – Problems with and Commentary on Determining Testing Requirement (Page 90)

Link: 7.2.5 – Proposed Solutions for Determining Testing Requirement Deficiencies (Page129)

4.3 Phase III - Validation, Approval, and Submission of the TMR

The MCCDC ARO initiated a multi-step validation process for the TMR to support the POM-10 process. Draft results were provided to MARFOR and MEF ammunition officers, MARCORSYSCOM and PP&O for comment and to MCCDC OAD for analysis. As these organizations noted issues, concerns and/or problems in the draft TMR, additional WRMR model and data modifications were performed, the WRMR model was re-run, and the new draft results were again distributed for comment and analysis.

After addressing issues, concerns and problems identified in the second review, a draft final TMR was generated and staffed through MCCDC's Senior Analyst and the commander of MCCDC LID, providing them the opportunity to identify additional issues or request additional information pertaining to specific calculations. The Senior Analyst, for instance, requested a detailed description of the methodology for utilizing and transposing JMEM data output into WRMR model input. On 22 January 2008, the final TMR was approved by the Capabilities Development Directorate (CDD) and submitted to DoD.

Link: 5.3 – Problems with and Commentary on the Validation, Approval, and Submission of the TMR (Page 90)

Link: 7.3 – Proposed Solutions for the Validation, Approval, and Submission of the TMR (Page 129)

5 Issues, Concerns and Problems with Current Marine Corps MRP

The following section describes issues, concerns and problems within the current Marine Corps munitions requirements process as identified by this study. Where appropriate, commentary is provided to explain the validity of the current methodology in cases where acceptable alternatives are not available or feasible, or to provide historical context regarding the decisions or data that influenced the current process.

5.1 Phase I – Data Collection

5.1.1 DoD-Generated Data

5.1.1.1 Implementation Guidance

The October 2007 pre-coordination draft of DoDI 3000.4 that was to be used in the POM-10 MRP stated that the Services were to use the Implementation Guidance in determining their CR, CO/FP and SR force structures. However, the Implementation Guidance provided by USD (AT&L) to support the POM-10 MRP was not signed, nor did it provide guidance regarding CO/FP or SR forces.

In response to the 2007 precoordination draft of DoDI 3000.4, the MCCDC ARO attempted to address the lack of detailed instructions regarding CO/FP and SR capabilities in the Implementation Guidance. Comments #1, #4, and #5 items in the Comments Matrix for DoD Issuances (see link to this document in Bibliography) requests detailed guidance be provided to the Services to ensure like assumptions are used in the CO/FPR and SRR calculations. Version 6 of the proposed revision of DoDI 3000.4, however, did not address these issues. Thus, it is still unclear whether the CO/FP force structure information to be developed by the CJCS will be incorporated into future Implementation Guidance and, if so, whether this guidance will vaguely refer to utilizing the Analytical Agenda or provide specific guidance on which SSSPs are to be utilized by each Service and detail the forces to be employed in each SSSP.[16]

Link: 4.1.1.1 – Current Methodology for Implementation Guidance (Page 41)

Link: 7.1.1.1 – Proposed Solutions for Implementation Guidance Deficiencies (Page 101)

[16] Version 6 of the proposed revision of DoDI 3000.4 omits reference to the SRR. The CJCS, in coordination with the COCOMs and Services, is assigned responsibility for defining the CO/FP capabilities. See sections 5.1.2.5 and 5.1.2.6 for more details.

5.1.1.2 Threat Reports

The DIA Threat Reports (TRs) are based on the JCOFA database and not on the near- or out-year ABLs that are developed by the COCOMs as part of the Analytical Agenda. The JCOFA process uses unit templates for enemy force structure and TO&E, as opposed to the specific unit definitions and TO&E defined in the ABLs. The different approaches mean that the TRs are frequently inconsistent with the theater's position on the enemy forces and quantity of maneuver targets.

For fixed targets, DIA provides a list of all targets in the MIDB for the near-year TR and publishes the same numbers for the out-year TR. Neither near-year nor out-year TRs account for potential discovery of targets during campaign execution. Further, the out-year TR does not account for the construction of new facilities, and does not seem to satisfy the guidance provided in the signed 2003 DoDI 3000.4 which states "the listing shall also identify known priority targets, as well as the quantities of ***estimated*** future targets" (emphasis added).[17] These issues frequently lead to inconsistencies between DIA's TRs and the COCOMs' expected requirements. For instance, USFK repeatedly requests additional underground facilities be added to the TR to account for the numerous suspected tunnels as well as the tunnels that will likely be built, based upon historical precedent, in the coming years.

The TRs supporting the POM-10 process also had some inconsistencies when defining fixed facility targets. For instance, all facilities at an airbase were defined as a single airbase target, whereas naval bases had each individual facility (i.e. BE number) defined as a separate target, producing an excessively large number of naval bases. This inconsistency can produce errors if not noticed and accounted for when the Services coordinate with the COCOMs on the development of target templates.

The discrepancies between the targets defined in a TR and the COCOM positions often lead to delays in the completion and distribution of a final TR. These delays cascade through the MRP, as the COCOMs cannot develop the near-year PTD until they receive the TRs, J-8 cannot develop the out-year PTD until they receive the COCOMs' near-year PTDs, and so on.

In addition, DIA is directed by all versions of DoDI 3000.4 to provide estimates of target reconstitution/ regeneration rates, battle-damage assessment (BDA) rates, as well as representative target templates for multi-element, fixed-target types. The TRs developed over the last few MRP cycles, however, have not contained this information. This leaves the COCOMs and Services to independently determine these elements, introducing the opportunity for inconsistent methodologies and values.

Link: 4.1.1.2 – Current Methodology for Threat Report (Page 41)

[17] None of the proposed revisions of DoDI 3000.4 evaluated during this study stated that DIA was to provide "estimates" of future targets.

Link: 7.1.1.2 – Proposed Solutions for Threat Report Deficiencies (Page 101)

5.1.1.3 Near-Year PTDs

The GAR Study Team believes that DoD does not place the same emphasis on the near-year PTD as the out-year. For example, the 2007 pre-coordination proposed revision to DoDI 3000.4 provides detailed guidance on the development of the out-year PTD as follows:

> [DPA&E is to] Use good military judgment, in concert with a suite of appropriate theater/campaign analysis and modeling tools (e.g., Thunder, Synthetic Theater Operations Research Model (STORM), Joint Integrated Contingency Model (JICM), Tactical Warfare (TACWAR), Conventional Targeting Effectiveness Model (CTEM), Combat Forces Assessment Model (CFAM), and Integrated Theater Engagement Model (ITEM)), to develop the out-year PTDs.

In contrast, none of the versions of DoDI 3000.4 has provided detailed guidance or made similar requirements for the COCOMs in their development of the near-year PTDs.

The problem with this disparity in emphasis can be seen in the fact that J-8 WAD uses the near-year PTD allocations as the basis for the out-year PTD allocation, meaning the validity of the out-year PTD is wholly dependent upon the accuracy of the near-year PTD.

Absent clear guidance about the detailed development of a PTD the COCOMs take a variety of approaches. Coordination with the COCOMs is necessary if the near-year PTD is to be understood by the Service and J-8 analysts. In fact, however, this coordination is difficult and seldom performed. Consequently, misunderstandings can occur that have significant implications for munitions estimates. For example, a COCOM's approach to the PTD may intuitively place targets assigned to Marine rotary-wing assets in the Marine Ground apportionment. Marine Corps aviation munitions, however, are the responsibility of the Navy and, as such, cannot be accounted for in the USMC MRP. Similarly, if the COCOMs account for the repair and return to service of combat equipment during a campaign, and the number of targets requiring destruction in the PTD submission includes these pieces of equipment potentially being struck more than once, the Services must understand this and not account for repair during their munitions requirements modeling efforts.

Service review of and concurrence with the near-year PTDs is complicated by inconsistent methodologies and reporting submissions by each of the COCOMs. For example, of the three 2007 PTD submissions, the Services initially concurred only with USFK's. The Services requested modifications to the PACOM submission which eventually resulted in acceptance. CENTCOM's submission was hampered by the classification and compartmentalization levels of the scenario and OPLAN input data used in modeling to generate the PTD. Although the Services identified issues with the PTD, they eventually accepted the submission even as they lacked any ability to review the compartmentalized input data.

Link: 4.1.1.3 – Current Methodology for Near-Year PTD (Page 42)

Link: 7.1.1.3 – Proposed Solutions for Near-Year PTD Deficiencies (Page 102)

5.1.1.4 Out-Year PTDs

It is critical to note that, excluding exceptional cases, the percentage of targets assigned to the Marine ground forces in the out-year PTD are the same as those found in the near-year PTD. This means that it is imperative that the near-year PTDs are accurate. It also means that the near-year PTD is actually the primary means of determining out-year munitions requirements and influencing the POM process.

If the ground apportionment in the out-year PTD continues to be directly derived from the near-year PTD, the COCOMs must ensure that target apportionment for Marine rotary-wing assets are placed in the air portion of the near-year PTD. Currently, J-8 WAD confirmed that it accounts for rotary-wing platforms in the air apportionment of the out-year PTD. Without the coordination described above, J-8 WAD has no ability to recognize how targets for rotary-wing aircraft are apportioned by the COCOMs, leading to inaccurate apportionments in the out-year PTD.

As with the near-year PTD, the out-year PTD should include the TPFDD or other force flow documents used so that the same forces and timing of arrivals can be defined in the WRMR input database.

Similarly, if the COCOMs account for repair and replacement of maneuver equipment during development of the near-year PTD, it is important for the J-8 analysts to know and account for this.

Link: 4.1.1.4 – Current Methodology for Out-Year PTD (Page 42)

Link: 7.1.1.4 – Proposed Solutions for Out-Year PTD Deficiencies (Page 103)

5.1.1.5 Analytical Agenda

As currently envisioned, the ABLs provide only two data elements needed for the MCCDC MRP data requirements, a CONPLAN/OPLAN for the WD or SD scenarios as well as the supporting analysis performed by the theater defining the expected timing of operations and scheme of maneuver. Upon inspection of the PACOM and USFK ABLs on the JDS web site[18], the GAR Study Team determined that obtaining this, or any other, information from the ABLs may prove difficult as no uniformity exists between any of the COCOM ABLs. Given the vagueness of the guidance provided by the JADM SC to the COCOMs regarding ABL development, each COCOM provides completely different data in unique formats with varying levels of supporting documentation. In addition, if a COCOM uses a

[18] The CENTCOM ABL had recently been updated. After the update, users were notified that an update had been posted, but the users which previously had access to this data were not provided with access to the newly updated information. Thus, the GAR Study Team was not able to view the CENTCOM ABL and determine its contents.

compartmentalized OPLAN to develop its PTD, such as the one used by CENTCOM during the MRP supporting POM-10, the ABL will not be a useful source of data for the WRMR model because security restrictions will make it impossible to use in the current modeling environment.

MCCDC will require access to other parts of the Analytical Agenda, including the Steady State Security Postures (SSSPs) and their respective MSFDs, if USD (AT&L) or the CJCS define the CPG vignettes to be used when determining CO/FP and SR capabilities, as is stipulated in the proposed versions 4 and 6 revision of DoDI 3000.4. A potential problem might arise if USD (AT&L) or the CJCS selects a vignette that does not include contributions by one or more of the Services, which occurred during the POM-10 MRP.

Both Government and civilian analysts have found obtaining access to the ABLs on the JDS website is a time-consuming effort. After submission of a request for a particular ABL, JDS notifies the COCOM or PA&E to request authorization for release of the specific ABL. Justification for the need to access these ABLs is also required by JDS from the requesting agency, and may require senior-level action, creating additional delays.

Link: 4.1.1.5 – Current Methodology for Analytical Agenda (Page 43)

Link: 7.1.1.5 – Proposed Solutions for Analytical Agenda Deficiencies (Page 103)

5.1.2 WRMR Model Data

The GAR Study Team has identified three major issues associated with all of the data used by the WRMR model to generate the TMR. First, there is little to no traceability to the current data used by the model, when the values were last reviewed, and what assumptions were made to generate the data in cases where a value is based on subject matter expertise as opposed to being derived mathematically. Second, in the case of SME-supplied inputs, no Marine organizations have been identified as the authoritative sources of this data, preventing an orderly, periodic review of the data by qualified specialists. Finally, none of the WRMR model input is reviewed by a senior-level oversight body, which would allow an early opportunity for decision makers to ensure the MRP is founded on verified and well-understood information and assumptions.

Link: 4.1.2 – Current Methodology for WRMR Model Data (Page 44))

Link: 7.1.2 – Proposed Solutions for WRMR Model Data Discrepancies (Page 103)

5.1.2.1 TPFDD

As the COCOMs develop the PTDs they utilize the approved TPFDD, or other force flow documents, developed in accordance with the OPLAN/CONPLAN. By the time the PTD is submitted and MCCDC initiates the development phase of the MRP, the TPFDDs for any of the theaters may have been updated and modified. When receiving TPFDDs directly from the MARFORs or MEFs, MCCDC cannot be sure they are utilizing the same TPFDD that

was used by the COCOM staff to develop the PTD. If the flow of Marine forces has changed significantly between the force flow used for PTD development and that used for MRP development, the WRMR model may provide unrealistic expenditure rates for various DODICs.

Link: 4.1.2.1 – Current Methodology for TPFDD (Page 45)

Link: 7.1.2.1 – Proposed Solutions for TPFDD Deficiencies (Page 104)

5.1.2.2 JMEM

The current methodology of applying JMEM data in the WRMR model is valid, and the use of JMEM data is consistent with the requirements defined in the proposed versions 4 and 6 revision of DoDI 3000.4; however, three issues merit attention.

JWES does provide a method for calculating average rounds per kill for a weapon-target pairing. To explore this capability, the GAR Study Team created a target-shooter combination in the JWES model. The resultant Pk was less than 1.0, and significantly less in a number of cases dependent upon range, yet the average rounds per kill for all ranges was 1.0. The seeming lack of correlation between the Pk and average rounds per kill merits further exploration of the JWES methodology. The documentation for this capability is provided separately from the JWES model, and the implementation as described in the documentation should be verified.

Also, no method currently exists to quickly and accurately trace the historical changes to the JMEM data within the WRMR model. This is a cause for concern as it precludes transparency into changes in the TMR estimates over time. Lacking such traceability, it is also unclear how effective the Marines' electronic submissions (meetings also provide a forum for requests, but historically the Marines haven't been represented) have been in encouraging the JTCG/ME to develop the data required by the Marine Corps.

Lastly, the target templates created for indirect-fire attrition are legacy templates of unclear origin or accuracy. Further, these target templates were not developed with the assistance of the COCOMs, as is required by all versions of DoDI 3000.4.

Link: 4.1.2.2 – Current Methodology for JMEM (Page 45)

Link: 7.1.2.2 – Proposed Solutions for JMEM Deficiencies (Page 104)

5.1.2.3 SME Input

As stated earlier, the SME inputs originated with the earlier Marine Corps Ammunition Requirements Management System (MCARMS) database. Quantics, Inc., the WRMR model developers, stated a majority, but not all, of the SME inputs have been updated or reviewed for accuracy over the past several years. In 2004, a comprehensive effort was made to identify a team of SMEs that would be able to review all inputs to the model.

While a significant portion of the database was reviewed, some input judgments were not reviewed due to a failure to locate a qualified SME to participate in the process.

Although it is possible for any given input to be located via the configuration control system on the file server maintained by the maintainers of the WRMR model, no documentation or coordinated system is currently in place to identify sources of the data elements, last date reviewed, as well as assumptions or limitations that affected the value entered into the model.

Link: 4.1.2.3 – Current Methodology for SME Input (Page 47)

Link: 7.1.2.3 – Proposed Solutions for SME Input Deficiencies (Page 105)

5.1.2.4 OPLAN Alignment

The MRP for POM-10 was the first time the Marine Corps attempted to align the battle phases defined in the WRMR model with the OPLAN/CONPLAN scheme of maneuver and anticipated timing as determined by the COCOMs. An ad hoc method was used, with the MARFORs requested to provide assistance via e-mail, which resulted in varied results. MARFORPAC's submission was not in the required format and the ARO performed modifications to the submission to ensure that it was sufficient for entry into the WRMR model. These changes were reviewed again by MARFORPAC to ensure accuracy. MARFORCENT's submission was directly entered into the WRMR model database.

In addition, although the final OPLAN alignments were validated with the relevant MARFORs, no coordination occurred with the COCOMs to verify that the commander's intent was being satisfied. All versions of DoDI 3000.4 indicate that target-templates and other assumptions in the Services' modeling efforts should be coordinated with the COCOMs.

Link: 4.1.2.4 – Current Methodology for OPLAN Alignment (Page 47)

Link: 7.1.2.4 – Proposed Solutions for OPLAN Alignment Deficiencies (Page 106)

5.1.2.5 CO/FP Capabilities

Based on interviews with personnel from PP&O, it is clear that the assumptions and reasoning used originally in the POM-06 process and again in the POM-08 and POM-10 processes to develop the CO/FP force structure and number of days of assault/sustained fire required for these forces are not traceable. With this being the case, it was not possible for the GAR Study Team to determine whether the current CO/FP capabilities used for the POM-10 TMR are valid or accurate. This also reinforces the point that traceability of the input data is necessary to validate the output of the model used to generate the TMR.

Link: 4.1.2.5 – Current Methodology for CO/FP Capabilities (Page 48)

Link: 7.1.2.5 – Proposed Solutions for CO/FP Capability Deficiencies (Page 106)

5.1.2.6 SR Capabilities

As is the case with the CO/FP, the assumptions and reasoning used to develop the SR force structure and number of days of assault/sustained fire required for these forces are not clear. Current PP&O personnel indicated the Homeland Defense and the Government War On Terror portions of the strategic readiness requirement may no longer be required and that it is not necessary to include Unit Deployment Program forces. Analysts at MCCDC OAD also noted that the 30 days of assault defined as necessary to support the Marine Corps Pre-Position-Norway might be excessive as the requirements for a number of DODICs exceeds the requirements generated for the WD scenario.

Link: 4.1.2.6 – Current Methodology for Determining SR Capability (Page 48)

Link: 7.1.2.6 – Proposed Solutions for Determining SR Capability Deficiencies (Page 107)

5.2 Phase II: Execution of TMR

5.2.1 Compute Combat Requirements

The GAR Study Team identified issues, concerns and problems in seven areas of the WRMR Model. These are discussed in detail below.

5.2.1.1 Target-Oriented Munitions Expenditures

As noted earlier, the WRMR V&V Study determined that the target-oriented expenditure methodology as represented in the WRMR model is valid, and the process has been accredited by MCDCC to define combat munitions requirements in support of the POM process. Expanding on that effort, the GAR Study Team documented the potential for four elements of the WRMR Model to have significant effects on the calculation of expenditures and therefore merit close attention be paid to their supporting data and application to future TMR production.

WRMR Model Equipment Repair Calculations

The POM-10 TMR was, as discussed earlier, the first to use the WRMR Model in a configuration that did not account for repair of enemy equipment and their return to the target set. However, given that previous TMR submissions were produced with the WRMR Model configuration that did factor in repair, and the possibility that future TMR submissions may do so, it is important to understand the range of estimates that could be generated.

The WRMR model utilizes JMEM data, where available, to determine the probability of repair for each enemy equipment type based upon the effectiveness of the attacking munition. Each equipment type also has a number of days required to complete the repair, which is dependent on the type of attacking munition. In addition to the probability of repair, the WRMR model's *param.in* data file contains a value called 'Target Repair Adjustment'

which is dimensioned by posture and whether the target is exposed or in defilade. This Target Repair Adjustment is a multiplier on the probability of repair that represents, in essence, the probability that a piece of equipment is recoverable from the battlefield once it is struck.

Table 5-1 below provides a comparison of results from three different WRMR model runs. The Base run represents combat expenditures for a WD scenario using the Target Repair Adjustment values currently defined in the WRMR model database (1.0 for Defend or Delay and 0.5 for Secure when target is exposed, 0.0 for all other postures and when targets are in defilade). The 100% Repair represents munitions expenditures where all Target Repair Adjustment values have been set to 1, indicating JMEM probability of repair tables are the only determining factor in the calculation. Finally, the 0% Repair represents munitions expenditures where all Target Repair Adjustment values have been set to 0, meaning no equipment repair ever occurs.

Munition	DODIC	Expenditures		
		Base	100% Repair (Δ%)	0% Repair (Δ%)
5.56mm Ball M855	A059	11,121,543	44,254,244 (298%)	9,586,589 (-14%)
60mm HE M734	B642	33,938	72,724 (114%)	34,112 (1%)[19]
81mm HE M821	C868	211,986	249,613 (18%)	123,042 (-42%)
120mm HE	CMPH	6,259	84,856 (1256%)	995 (-84%)
155mm HE M795	D529	151,049	259,852 (72%)	68,578 (-55%)

Table 5-1: Comparison of the Effects of Repair Rates on Munition Expenditures [20]

[19] It is possible that a slight increase in one weapon system, such as the 60mm mortar system, and a similar decrease in another system such as the 81mm mortar system, could produce an anomaly similar to the one presented here where the 0% repair case actually causes a slight percentage increase in a given weapon system's expenditures. The 60mm mortar, as discussed in section 5.2.1.6, plays a limited role in enemy target attrition, meaning that slight changes in friendly and enemy force structures could lead to the 60mm mortar not being attrited on a given day. This weapon would not expend target-oriented munitions on these days, but would continue to expend registration rounds.

[20] Note that due to the values of the Base data, the 0% scenario is expected to be closer, but not exactly the same as, the Base results. The variation between the Base and 0% scenarios is due to a number of factors, including the percent of time within attack/defend postures, which leads to variations in enemy equipment being exposed/in-defilade, which determines expenditures per kill when the enemy unit is exposed/in-defilade. Thus, defining a direct relationship here is difficult, but the purpose of the table is to simply show the degree of variability in the results based upon the value provided in the Target Repair Adjustment data.

This comparison clearly shows that the values used for the Target Repair Adjustment can dramatically influence expenditure calculations and therefore must be based on sound research and analysis. The size of the potential difference between cases makes it important that the existing values in the WRMR model data be validated, with traceability to their origins.

The 100% Repair case, however, exposes another potential issue. The WRMR model allows only a single value to define the probability of repair for equipment regardless of the length of a conflict. This means that a tank struck during Phase III has the same probability of repair as a tank struck on day one. Consequently, the model does not account for the changes in the enemy's ability to repair equipment as a function of damage to the state of its maintenance and logistical facilities over time. This misrepresentation of repair capacity means the estimates for munitions needed to destroy each of the targets in the PTD will be unrealistically high.

WRMR Model Friendly Force Attrition Methodology

The WRMR model calculates daily friendly losses based on the quantity of enemy forces destroyed in a given day.

Table 5-2 below shows the impact of varying the loss-exchange ratio within the WRMR model. Note that the differences between the two bounds of one-to-one friendly-to-enemy attrition and no friendly losses whatsoever varies the expenditures between 5-25%. Although the effect is much smaller than the impact of repair on modeling results as discussed above, these variations are significant enough to warrant additional investigation to ensure they are reasonably accurate.

Munition	DODIC	Expenditures (based on Friendly : Enemy loss ratio)				
		1:1	1:2	1:3	1:4	No Friendly Losses
5.56mm Ball M855	A059	11,599,696	11,050,895	10,883,039	10,807,449	10,351,789
60mm HE M734	B642	28,884	34,373	36,429	37,123	37,156
81mm HE M821	C868	185,805	216,696	227,941	228,295	275,972

		Expenditures (based on Friendly : Enemy loss ratio)				
120mm HE	CMPH	5,634	6,201	6,059	5,990	5,874
155mm HE M795	D529	149,202	153,470	158,682	162,677	171,084

Table 5-2: Comparison of Effects of Friendly-To-Enemy Loss Rates On Munition Expenditures in the WRMR Model [21]

Target "Clumping"

The WRMR Model needs to produce "assault" and "sustained" rates of munitions expenditures to be used as combat planning factors and to calculate estimates for the SRR and CO/FPR. To generate these two rates, the WRMR model currently defines two target groups, a high-intensity set with a user-defined percentage of the targets for a given phase, and the remaining targets placed in a low-intensity set. The model then calculates how long it would take to destroy all of the high-intensity targets as a function of the maximum daily expenditure rate of the engaged weapon systems. The low-intensity targets are then spread evenly over the days remaining after the high-intensity set is destroyed.

As is stated in WRMR Survey #3[22], this makes the assumption that each phase comprises a single period of high-intensity combat in which the majority of targets will be attrited, and that the remainder of the phase will experience low-intensity conflict. This type of assumption may be valid for the standard phases of a campaign overall, but is insufficient to represent the behavior of Marine Corps combat units. Based on the recommendations of the WRMR V&V Study Team, however, the latest WRMR model data incorporates a number of sub-phases, called battle phases in the WRMR model. This change gives the model the flexibility to more closely align with a COCOM's OPLAN by allowing Marine Corps forces to operate at a varied pace throughout a given phase of the campaign as they perform expeditionary operations, establish a beachhead, undertake passage of lines with non-Marine Corps follow-on and follow-up forces, and reconstitute for a period of time until ordered to perform another operation. The change, however, does not allow for the target set to be

[21] It should not be assumed that reduced losses in USMC weapon systems will necessarily increase the expenditures of those systems. DODIC A059 likely decreased as a result of mortar and artillery fire destroying more targets, leaving a smaller percentage for small arms to attrit. It is currently unclear, however, why the 120mm HE rounds experience an increase and then a decrease as the friendly: enemy loss ratio becomes more favorable. It may also be due to the mix of friendly and enemy weapon systems available on the battlefield at a given time, but further investigation would be required to confirm that this is the case.

[22] Quantics, Inc. developed 28 surveys in support of the WRMR V&V Study Team. The surveys were to be sent to SMEs throughout the Marine Corps to verify the methodologies used in the WRMR model and establish that the data required to support these methods are reasonable and obtainable. The surveys were never distributed, however, as the WRMR Model V&V Study Team estimated that the responses would likely not differ significantly from those received in the original distribution of similar surveys in 2004. The structure of the surveys nevertheless provided the GAR Study Team valuable, concise descriptions of how the WRMR model calculates each component of the TMR.

similarly distributed in order to account for the possibility of multiple periods of high- and/or low-intensity combat throughout a given phase. This potentially leads to inaccuracies in the calculation of the assault (high-intensity) and sustained (low-intensity) CPFs. Since the CPFs are used to calculate the CO/FPR and SRR, additional erroneous values will be introduced into the final TMR.

Without a complete non-aligned excursion to compare against the aligned version used for the most recent TMR, it is difficult to assess precisely what impact the OPLAN alignment had on the POM-10 submission. To provide a rough estimate, however, the GAR Study Team attempted to recreate a version where OPLAN alignment was not performed, such that all days of ATTACK posture are placed at the beginning of a battle phase, followed by all days of DEFEND, and finally all days of SECURE. A comparison of the Baseline (with OPLAN alignment) and this altered posture structure can be found in Table 5-3 below.

Munition	DODIC	Combat Expenditures No OPLAN Alignment	Combat Expenditures Baseline	Percentage Increase
5.56mm Ball M855	A059	10,506,736	11,121,543	5.9%
60mm HE M734	B642	30,852	33,938	10.0%[23]
81mm HE M821	C868	155,195	211,986	36.6%
120mm HE	CMPH	1,297	6,259	382.6%
155mm HE M795	D529	127,463	151,049	18.5%

Table 5-3: Impact of OPLAN Alignment on Sample Combat Expenditures

Table 5-3 shows the increase of expenditures experienced when the WRMR model is aligned with the WD scenario. As the increased expenditures influence the CPFs generated by the model, the CO/FPR and SRR estimates are also affected.

User-Defined Data Values for Suppressive Fires

The WRMR model database currently has the same values for every type of munition that provides suppressive fires. These data values indicate that approximately 91% of all rounds fired will be used for suppressive fires and only approximately 9% will be used to attrit enemy targets.

[23] The relatively low decrease in expenditures of DODIC B642, 60mm Mortar HE, is due to the fact that registration expenditures comprise the overwhelming majority of combat expenditures for this round type. See Section 5.2.1.6 for more information.

Link: 4.2.1.1 – Current Methodology for Target-Oriented Munition Expenditures (Page 50)

Link: 7.2.1.1 – Proposed Solutions for Target-Oriented Munition Expenditures Deficiencies (Page 108)

5.2.1.2 Illumination and Obscuration Expenditures

The GAR Study Team, like the WRMR Model V&V Study Team before it, identified this category as the model's most glaring problem. As noted in the final report of the V&V study, the WRMR model generated illumination requirements for applicable weapon systems that were between 25-80% of their anti-personnel/anti-material (AP/AM) munitions requirements, even though illumination rounds only comprised approximately 10% of the weapon system-specific combat load. (Wood, 2007)

The current methodology has two fundamental flaws. First, the requirement is not defined as the overall daily number of smoke/illumination minutes required by infantry company, but the requirement is instead defined as the daily number of smoke/illumination minutes required by infantry company by supporting system. This data is difficult for a single SME to provide. An experienced commander of an infantry company should understand the number of minutes of smoke or illumination required during an average day of combat, but will not be as concerned about the distribution of these minutes to the supporting systems as this would be a factor that would vary with each engagement. Likewise, artillery commanders should understand their specific system capabilities with regard to providing smoke and illumination support, but would likely find it difficult to provide an expected level of support per infantry company while taking into account the other types of support systems in other units that may be available to the infantry unit. The SME-supplied values for levels of support currently in the WRMR model database indicate that a total of 4 hours, 16 minutes of illumination is required for each infantry company each day spent in the DEFENSE posture, and 2 hours, 29 minutes per infantry company per day in all other postures. These values seem excessive as a modern daily average, and this excess is very likely a result of the SMEs' failure to fully understand this calculation and to be able to derive accurate numbers to support it.

The second problem is that the requirement is disassociated from the number of supporting systems available. As the number of infantry companies increase, the requirement increases regardless of whether or not the supporting systems' sustained rate of fire can satisfy these requirements. In scenarios where the deployment of infantry units precedes deployment of artillery support, it is possible for the WRMR model to provide expenditure rates that far exceed the capabilities of the smoke/illumination dispensing systems. The WRMR model has an option to restrict the expenditure based on the combat load, but this option only constrains the generated combat planning factor and does not actually affect the number of smoke or illumination rounds expended.

Link: 4.2.1.2 – Current Methodology for Illumination/Obscuration Expenditures (Page 54)

Link: 7.2.1.2 – Proposed Solutions for Illumination/Obscuration Expenditures Deficiencies
(Page 111)

5.2.1.3 Rear-Area Security Expenditures

The problem with this calculation is that it does not accurately reflect how rear-area security operations occur, making it difficult for SMEs to provide accurate assessments of expenditures per weapon per day. Most rear-area security expenditures are by base or convoy defense personnel. The quantity of weapons that these forces maintain are relatively small compared to the overall number of weapons in the rear area due to the fact that nearly all personnel, including those in administrative, logistics, and other support units, possess a weapon while in theater. Thus, with current SME data, the WRMR model's calculations for rear-area expenditures for many munitions exceeds the quantity expended in front-line combat operations, as is shown in Table 5-4 below.

Munition	DODIC	Rear Area Expenditures	Target-Oriented Expenditures	Total Combat Requirement	RA as % of Tgt-Oriented	RA as % of CR
5.56mm Ball M855	A059	5,746,903	1,681,739	11,121,543	341.7%	51.7%
Cartridge, 5.56mm Tracer M856	A063	283,598	229,919	597,114	123.3%	47.5%
Cartridge, 7.62mm 4 Ball M80/1 Tracer M62 Linked	A131	643,434	2,865,913	4,323,740	22.4%	14.9%
Cartridge, Caliber .50 4 API M8/1 API-T M20 Linked	A576	383,076	1,501,145	2,304,023	25.5%	16.6%

Table 5-4: Rear-Area Expenditures Compared with Target-Oriented and Total Combat Expenditures

Given the force flow of Marine units and positioning of these units when not in combat for the WD scenario, it is highly unlikely that nearly 3.5 times as many rounds will be expended in rear-area security as in front-line operations.

Another problem with this calculation is that, while the value for the number of rounds

expended per weapon per day is adjustable by unit posture, it is not adjustable by theater.

Link: 4.2.1.3 – Current Methodology for Rear-Area Security Expenditures (Page 55)

Link: 7.2.1.3 – Proposed Solutions for Rear-Area Security Expenditures Deficiencies (Page 116)

5.2.1.4 Self-Defense Expenditures

While the intent is to use the WRMR model's self-defense category to capture expenditures not accounted for in other modules, in practice this seems to be increasing the combat requirement by double-counting certain items. For the non-GCE weapons, small arms expenditures are already included in the rear-area formula. Given that rear-area security is calculated based upon all non-GCE weapons and not just those belonging to security forces, it is unclear how differentiation is currently made between self-defense and rear-area security.

For GCE weapons, the target-based expenditures against elements of the PTD adequately represent expenditures by front-line forces. Certain GCE weapon systems, such as sniper rifles, are not accounted for in the target-based expenditure methodology. The inclusion of these in the self-defense formula does not represent a double-count, even if the category name is somewhat inappropriate for the purpose.

Link: 4.2.1.4 – Current Methodology for Self-Defense Expenditures (Page 55)

Link: 7.2.1.4 – Proposed Solutions for Self-Defense Expenditures Deficiencies (Page 117)

5.2.1.5 Operational Check Expenditures

The 10% value in the formula used by the WRMR model is derived from SMEs and estimates an operational check is required once every 10 days. This value is currently hard-coded in the WRMR model because the original designers could not determine where and how the value should be represented in the WRMR model input data. Should this value change in the future, the WRMR model must be recompiled in order to account for the change.

Link: 4.2.1.5 – Current Methodology for Operational Check Expenditures (Page 56)

Link: 7.2.1.5 – Proposed Solutions for Operational Check Expenditures Deficiencies (Page 118)

5.2.1.6 Registration Expenditures

Initial observations indicated that this formula might dramatically overestimate the expenditures of select weapon systems. Table 5-5 indicates that the registration rounds account for 83% of all 60mm mortar high explosive round expenditures.

Weapon System (DODIC)	Registration Rounds (RR)	Combat Expenditures (CE)	RR as % of CE
60mm Mortar (B642)	28,167	33,938	83.0%
81mm Mortar (C868)	33,491	211,986	15.8%
155mm Howitzer (D529)	98	151,049	0.1%

Table 5-5: Registration Expenditures Compared to Combat Expenditures

Note the great disparity between the percentage of combat expenditures attributable to registration rounds being expended between the 60mm mortar and the other indirect-fire weapon systems. If a methodological error existed in the algorithm used by the model to calculate registration expenditures, it would be expected that the registration expenditure rate as a percentage of all combat expenditures would be similar for all weapon systems. , However, this is not the case, which indicates that it is most likely questionable data causing this variance.

Examining the input database, the expenditure/kill values for the 60mm and 81mm mortars both seemed reasonable, with the 81mm mortar generally requiring fewer rounds per kill. It was observed, however, that the 81mm mortar destroys a significantly larger number of targets, indicating that problems may exist in the weapon-to-target apportionment input data. Examining this data the GAR Study Team found that the 60mm mortar is assigned a very limited target set to attack, and receives a small allocation for these targets compared to other weapon systems. This leads to very few target-oriented expenditures by the 60mm mortar relative to other combat systems.

Thus, the large percentage of registration rounds expended as compared to total combat expenditures by the 60mm mortar is not due to the WRMR model methodology for determining registration rounds. Instead, it is due to the fact that the 60mm mortar expends very few munitions against targets due to the data provided by the SME. The GAR Study Team, therefore, assesses that the methodology used by the WRMR model to calculate registration rounds is valid.

Link: 4.2.1.6 – Current Methodology for Registration Expenditures (Page 57)

Link: 7.2.1.6 – Proposed Solutions for Registration Expenditures Deficiencies (Page 119)

5.2.1.7 Logistics Losses

Since the WRMR model provides each weapon system with one combat load initially, it does not account for munitions losses due to combat. For instance, if a tank is destroyed, the model does not account for the fraction of the combat load that may be lost along with this tank as this would be double-counting the requirement since, if the tank were destroyed, the

munitions lost would already be accounted for in the combat load it was initially provided.

Overall, the Study Team identified that the WRMR model methodology is valid and should lead to a relatively accurate assessment of requirements associated with logistical losses.

Link: 4.2.1.7 – Current Methodology for Logistics Losses (Page 57)

Link: 7.2.1.7 – Proposed Solutions for Logistics Losses Deficiencies (Page 119)

5.2.1.8 Demolition Expenditures

The GAR Study Team identified no issues, concerns or problems in the current methodology used by the WRMR model for determining demolition expenditures.

Link: 4.2.1.8 – Current Methodology for Demolition Expenditures (Page 58)

Link: 7.2.1.8 – Proposed Solutions for Demolition Expenditures Deficiencies (Page 119)

5.2.1.9 Mining Expenditures

The GAR Study Team identified no issues, concerns or problems in the current methodology used by the WRMR model for determining mining expenditures.

Link: 4.2.1.9 – Current Methodology for Mining Expenditures (Page 58)

Link: 7.2.1.9 – Proposed Solutions for Mining Expenditures Deficiencies (Page 119)

5.2.1.10 Zeroing Expenditures

The GAR Study Team identified no issues, concerns or problems in the current methodology used by the WRMR model for determining zeroing expenditures.

Link: 4.2.1.10 – Current Methodology for Zeroing Expenditures (Page 59)

Link: 7.2.1.10 – Proposed Solutions for Zeroing Expenditures Deficiencies (Page 119)

5.2.1.11 Screening Expenditures

The GAR Study Team identified no issues, concerns or problems in the current methodology used by the WRMR model for determining screening expenditures.

Link: 4.2.1.11 – Current Methodology for Screening Expenditures (Page 59)

Link: 7.2.1.11 – Proposed Solutions for Screening Expenditures Deficiencies (Page 120)

5.2.1.12 Command and Control Expenditures

The GAR Study Team identified no issues, concerns or problems in the current methodology used by the WRMR model for determining command and control expenditures.

Link: 4.2.1.12 – Current Methodology for Command and Control Expenditures (Page 59)

Link: 7.2.1.12 – Proposed Solutions for Command and Control Expenditures Deficiencies (Page 120)

5.2.1.13 EOD Expenditures

The GAR Study Team identified no issues, concerns or problems in the current methodology used by the WRMR model for determining EOD expenditures.

Link: 4.2.1.13 – Current Methodology for EOD Expenditures (Page 60)

Link: 7.2.1.13 – Proposed Solutions for EOD Expenditures Deficiencies (Page 120)

5.2.1.14 Ancillary Item Expenditures

The GAR Study Team identified no issues, concerns or problems in the current methodology used by the WRMR model for determining ancillary item expenditures.

Link: 4.2.1.14 – Current Methodology for Ancillary Item Expenditures (Page 61)

Link: 7.2.1.14 – Proposed Solutions for Ancillary Item Expenditures Deficiencies (Page 121)

5.2.2 Compute Combat Planning Factors

The GAR Study Team identified one step of the WRMR model algorithm used to generate CPFs that merits close examination. In circumstances where a weapon has a zero expenditure rate in more than half the days of a scenario, the sustained rate is designated as zero and the assault rate is calculated as the average of all non-zero daily expenditure rates. The possibility of this occurring has always been small, but it increases when proper OPLAN alignment is performed and Marine Corps forces are not designated to attack or defend throughout a campaign. In this case, where Marine Corps forces spend a large percentage of the time in the rear area preparing for operations, a sustained rate of zero is not accurate, as it does not represent the sustained rate of fire experienced during combat operations.

Issues regarding development and distribution of WRMR model-generated CPFs are detailed in section 8 of this report.

Link: 4.2.2 – Current Methodology for Computing Combat Planning Factors (Page 61)

Link: 7.2.2 – Proposed Solutions for Computing Combat Planning Factors Deficiencies (Page 121)

5.2.3 Compute CO/FPR and SRR

The CO/FPR and SRR are both calculated by multiplying an expenditure rate per day (a CPF) for a force by the number of days of anticipated engagement. (See section 8 for a discussion on the validity of the WRMR model-generated CPFs.) As long as the CO/FP and SR capabilities developed by PP&O or provided in the Implementation Guidance are accurate and valid, no modifications to the current methodology for calculating the CO/FPR and SRR are required.

Link: 4.2.3 – Current Methodology for Computing CO/FPR and SRR (Page 63)

Link: 7.2.3 – Proposed Solutions for Computing CO/FPR and SRR Deficiencies (Page 121)

5.2.4 Determine Training Requirement

5.2.4.1 Compute Training Requirements

Based on discussions with G-3 and G-4 representatives from TECOM, sustainment has generally increased as unit commanders have requested modifications to allowances due to changes in training requirements. These requests must be approved by the Ammunition Working Group, and, except in cases of short-term, unit-specific requirements, are applied to all like units throughout the Corps, with the associated changes being integrated into the annual training allowances in TAMIS-R. Reductions to sustainment training requirements have occurred in cases where use of specific ammunition types has been discontinued. The process required to change sustainment training allowances, including the roles and responsibilities of the various organizations involved, is not defined in TECOMO 8011.1.

TECOM has noted a number of discrepancies in the overall allocation of munitions and generation of its annual requirements. The greatest cause of concern focuses on the fact that all training requirements are based upon the aforementioned GTARG ’98 baseline, the validity of which was never verified by a follow-up GTARG. In addition, failure to maintain a centralized repository of changes, with the assumptions and conditions that mandated these modifications, since FY00 prevented the NAS from reverse-engineering current MCBul 8011 allocations to either formal USMC training standards or the GTARG baseline.

TAMIS-R is an invaluable tool for tracking munitions allowances, requests and expenditures, and has provided TECOM a means to support analysis of the accuracy of its munitions requirements process. TECOM has found that annual training allowances generated by using data from TAMIS-R generally result in figures that significantly exceeded training expenditures for nearly all DODICs, with most DODICs being expended at a rate of approximately 50-60% of the annual allowance. These low expenditure rates have a number of likely contributing factors:

Unit Deployments. Unit deployments in support of the current War on Terror, such as deployments in support of Operation Iraqi Freedom and Operation Enduring Freedom, as well humanitarian assistance missions to tsunami-stricken areas of the Pacific, the post-Katrina Gulf area of the U.S., and other regions have meant that training ammunition expenditures for some units have varied dramatically from year-to-year. These fluctuations in training requirements due to shifting mission requirements and inability to perform specified training due to deployments, along with misalignment between the geographical positioning of training ammunition and deployed units preclude an accurate expenditures-based methodology from being implemented to determine training requirements.

Insufficient Inventory. There have been a few instances where wartime requirements to support forces in Iraq and Afghanistan have prevented units from receiving adequate ammunition with which to train. TAMIS-R does not track inventory, so determining the frequency and extent to which insufficient inventory prevents units from completing their training requirements is difficult.

Safeguarding of Training Ammunition. Units frequently safeguard their training ammunition allocations, returning unused ammunition only at the end of the fiscal year, which prevents this ammunition from being redistributed to other units. MARFORs, MEFs, and Divisions conduct quarterly redistribution meetings, but special allowance requests often originate from subordinate units of these organizations. In many cases, the commanders and/or G-3/S-3s are not involved in the special allowance requests of their subordinate units and are, therefore, unable to reallocate resources from other subordinate units that have not expended their allowances.

Range Availability. The inability to obtain range time for training can prevent units from expending their ammunition allowance.

Given the lack of validity of an expenditures-based requirements methodology owing to the reasons described above, TECOM has focused its efforts on developing an approach based upon training requirements and standards, as defined in USMC Training & Readiness (T&R) Manuals. TECOM has also identified shortfalls in the T&R Manuals, involving the following issues:

- Not all T&R Manuals are complete;
- Not all units train to the same tasks;
- Many like-units are not identical in their basic organization;
- Some tasks can be performed concurrently or during exercises;
- T&R Manuals fail to account for non-infantry units being given provisional infantry-intensive missions, thereby requiring training ammunition that is not similar to that defined in the T&R Manuals; and

- T&R Manuals define the required munitions by task, but fail to define a *minimal level of proficiency* that may be acceptable under certain conditions and that could reduce the overall training munitions requirement.

A TECOM-sponsored study, *Ground Training Ammunition Requirements Determination Process – Phase 1* (December 2007), documented at least two additional issues. First, it determined that the practice and policy are consistent for calculations related to entry-level training and formal schools, marksmanship/common skills training, and previously established allowances. The documentation and traceability supporting these calculations, however, require improvement. Second, it noted that the current practice to determine exercise support and sustainment training requirements deviates from the policy as defined in TECOMO 8011.1. Since exercise planners outside of TECOM and G-4 provide the historical allowances in support of exercises, TECOM has no guarantee that the exercise planners are adhering to the guidance provided in TECOMO 8011.1.

Link: 4.2.4.1 – Current Methodology for Computing Training Requirements (Page 64)

Link: 7.2.4.1 – Proposed Solutions for Computing Training Requirements Deficiencies (Page 121)

5.2.4.2 Determine Title 10 Requirements

Prior to POM-10, TMR submissions did not include this requirement. With no indication that the US Government will cease providing allied nations munitions for these exercises, and given that US Code 2010 authorizes such expenditures, this seems to be a valid addition to the overall training requirement.

The MARFORs are the proper organizations to determine this requirement as they maintain the greatest understanding of the exercises and historical obligations provided to allied nations. If the Title 10 requirements are to be a part of the total training requirement, then it is inappropriate for these values to be added to TECOM's submission outside of their purview.

Link: 4.2.4.2 – Current Methodology for Determining Title 10 Requirements (Page 66)

Link: 7.2.4.2 – Proposed Solutions for Determining Title 10 Deficiencies (Page 127)

5.2.4.3 Compute Peacetime Pipeline (PPL) Requirements

Tracing the justification for and composition of a PPL element from DoD or Marine Corps orders or instructions is difficult to say the least.

The clearest definitions of the AAO and its components are from a letter from the CGMCCDC dated 12 July 1996, which states, "AAOs encompass the War Reserve Materiel Requirement (WRMR) and Testing and Training Requirements (TTR)…" The TTR is then defined as the sum of the testing requirement, training requirement, and training unique pipeline requirement. In addition, "The AAO for each individual DODIC equates to a Total

Munitions Requirement (TMR)…"

CMC letter 8000/R, dated 9 June 1997, defines the AAO as follows:

> Training unique items: AAO will equal the PPL.
>
> War Reserve only items: AAO will equal the WR.
>
> Dual-purpose items: AAO will equal the WR plus the PPL.[24]

In addition, it confirms that the PPL will be set at 313 days.

The 1997 MCO 8000.7 states:

> "CG MCCDC is responsible for computing the TMR, which is the sum of the WRMR, the training requirement, the testing requirement, and ***the training unique pipeline requirement***. The pipeline requirement consists of training specific ammunition that is an addition to the training requirement for training unique items only." (*emphasis added*)

Each of these documents indicates that the PPL is to be part of the TMR and AAO. More recent DoD and Marine Corps documents, however, fail to reference the PPL as part of the TMR or AAO. Neither any version of DoDI 3000.4 nor TECOMO 8011.1, however, indicates that a logistical pipeline is a part of the requirement for training munitions. Paragraph C9.3.2.1.1.1 of the DoD regulation 4140.1-R, *DoD Supply Chain Material Management Regulation*, dated 23 May 2003, approximately six months prior to the release of DoDI 3000.4, states that each Service will stratify its conventional munitions inventory into categories, including a requirement related munitions stock (RRMS). This RRMS is defined as:

> "The inventory of munitions stock, including preferred and substitutes, applied to the total munitions requirements (TMR), ***individual item procurement lead time***, and other elements that are applicable to internal Military-Service-level inventory management during stratification. The RRMS provides the Service with inventory support throughout the period of the POM and lead time to procure." (*emphasis added*)

This statement would seem to indicate that procurement lead time is independent of the TMR.

Paragraph 4.2 of the MARCORSYSCOM Commander's letter describing the ammunition estimation process, dated 8 June 2007, notes the apparent inconsistency described above by referencing DoD 4140.1-R and DoDI 3000.4 but then states that the Marine Corps guidance

[24] Dual-purpose munitions are those used for both training and combat operations.

provided in the 1997 letters is used to define the PPL and allow its inclusion in the TMR. The use of the 1997 guidance has been selective, however, as the requirement for training-specific munitions for the POM-10 TMR was developed by TECOM and was not equal to the PPL, and no PPL was defined for dual-purpose munitions.

Consequently, no consistent definition of the PPL is provided and the relationship between the AAO, PPL, and TMR is unclear.

Link: 4.2.4.3 – Current Methodology for Computing Peacetime Pipeline Requirements (Page 66)

Link: 7.2.4.3 – Proposed Solutions for Computing Peacetime Pipeline Requirements Deficiencies (Page 127)

5.2.5 Determine Testing Requirement

No issues, concerns or problems were noted with the current Marine Corps process in developing the testing requirement.

Link: 4.2.5 – Current Methodology for Determining Testing Requirements (Page 66)

Link: 7.2.5 – Proposed Solutions for Determining Testing Requirements Deficiencies (Page 129)

5.3 Phase III - Validation, Approval, and Submission of the TMR

Prior to POM-10, MRPs had essentially been produced through a "black box" approach. Results were generated without sufficient analysis being performed to ensure erroneous data or methodological problems produced inaccurate or invalid results. Although some staffing of the results was performed, accompanying documentation explaining the inputs, assumptions, and constraints was not given to those organizations requested to provide feedback. The final TMR was also approved and submitted without an explanatory briefing that provided the information necessary to completely answer leadership questions.

In contrast, the validation of the POM-10 TMR incorporated a series of analytical evaluations of the results followed by modifications and updates to the WRMR model and supporting data, followed by a multi-step validation and approval process.

The analysis performed by OAD personnel and comments by the GAR Study Team were critical in finding and proposing solutions for a number of significant problems including utilizing historical usage rates for obscuration and illumination expenditures, noting that repair should not be included in the WRMR modeling process as it was already accounted for by the COCOMs during PTD generation, as well as noting minor deficiencies in the WRMR model methodologies and calculations. The review of the draft TMR by the MARFOR and MEF ammunition officers, MARCORSYSCOM, and PP&O also identified dozens of issues with regards to specific DODICs. This type of input is invaluable as it is

difficult, if not impossible, for the MCCDC ARO to maintain complete knowledge of the 300+ DODICs, including retired/retiring munitions, newly deployed munitions, and each munition's use in every theater. The two-step validation process ensured that nearly all major and minor deficiencies were noted and addressed prior to submission to higher-level authorities.

The validation process, however, was developed ad-hoc and was not documented at the time. Requests for review of the draft TMR were distributed via e-mail and not through the Marine Corps Action Tracking System (MCATS), meaning the ARO was dependent upon the goodwill of the military and civilian reviewers. In addition, distribution of only the Excel spreadsheets containing tens of thousands of numbers with no reference material explaining the methodology and assumptions from which these were generated prevented the personnel at each stage of the validation process from making an informed judgment of the accuracy of the numbers. Regardless, feedback provided by the MEF and MARFOR ammunition officers, MARCORSYSCOM, and others was valuable in identifying potential errors. Although changes were made as a result of this feedback prior to submission of the final TMR, no formal system was used to document these issues and their resolution. Failure to properly document the validation process may prevent repeatability and traceability during future MRP cycles.

Finally, the submission of the TMR occurred without any comparative analysis between the POM-10 results and previous submissions of the TMR. Lacking such an analysis it is difficult to identify potential errors in input data or assumptions, justify sudden increases or decreases in the requirements of specific DODICs, and explain changes in the related CPFs.

Link: 4.3 – Current Methodology for Validation, Approval and Submission of the TMR (Page 67)

Link: 7.3 – Proposed Solutions for Validation, Approval and Submission of the TMR Deficiencies (Page 129)

6 The US Army Munitions Requirements Process

While DoDI 3000.4 also guides the US Army, it maintains no defined instruction or order, such as MCO 8000.7, describing its internal MRP. The process, however, is maintained in historical briefings and other documents that provide traceability and allows for repeatability over successive MRP cycles.

6.1 Phase I – Data Collection

The overall Army munitions requirements development process is shown in the conceptual illustration created by the GAR Study Team presented Figure 6-1 below. TRADOC provides combat loads for Army weapons systems. Major army commands (MACOMs) provide an Operational Needs Statement for deploying units and the Army Service Component Commands (ASCCs) provide the Operational Needs Statement for deployed units. The Department of the Army, Military Operations (DAMO) and the G-3/5/7 use the data provided by these organizations to determine force structure, capabilities and strategy.

To determine CO/FP and SR capabilities, the Army relies on four baseline security postures[25] (BSPs). BSPs are vignettes of potential future conflicts around the world developed by DoD with the support of the Services. These BSPs define the forces required by each Service to support the given operation associated with the vignette. The Army attempts to select four BSPs that are representative of a spectrum of operational types. This methodology is consistent with the guidance provided in the 23 October 2003 pre-coordination draft of DoDI 3000.4 that the Services utilize the Analytical Agenda when determining requirements.

CAA combines this data with information derived from the SPG, DIA TRs, and the Joint Capabilities Integration and Development System (JCIDS) to create portions of the database for the Joint Integrated Contingency Model (JICM), a deterministic, campaign-level tool used to calculate target-oriented expenditures. JICM modelers evaluate the COCOM's OPLAN or CONPLAN and attempt to accurately portray the scheme of maneuver and general flow of combat associated with the plan.

The assumptions, forces, and concepts of operation devised by Army organizations define the input to what is called the Quantitative War Reserve Requirements for Munitions (QWARRM) process and are validated by a Council of Colonels. This is a working group of senior Army leaders comprising representatives from CAA, the Assistant Secretary of the Army for Acquisition, Logistics and Technology, Department of the Army Headquarters for G-3, G-4, and G-8, the Joint Munitions Command, and the TRADOC Army Capabilities

[25] Baseline Security Postures will become Steady-State Security Postures in future analysis, per the Analytical Agenda.

Integration Center.

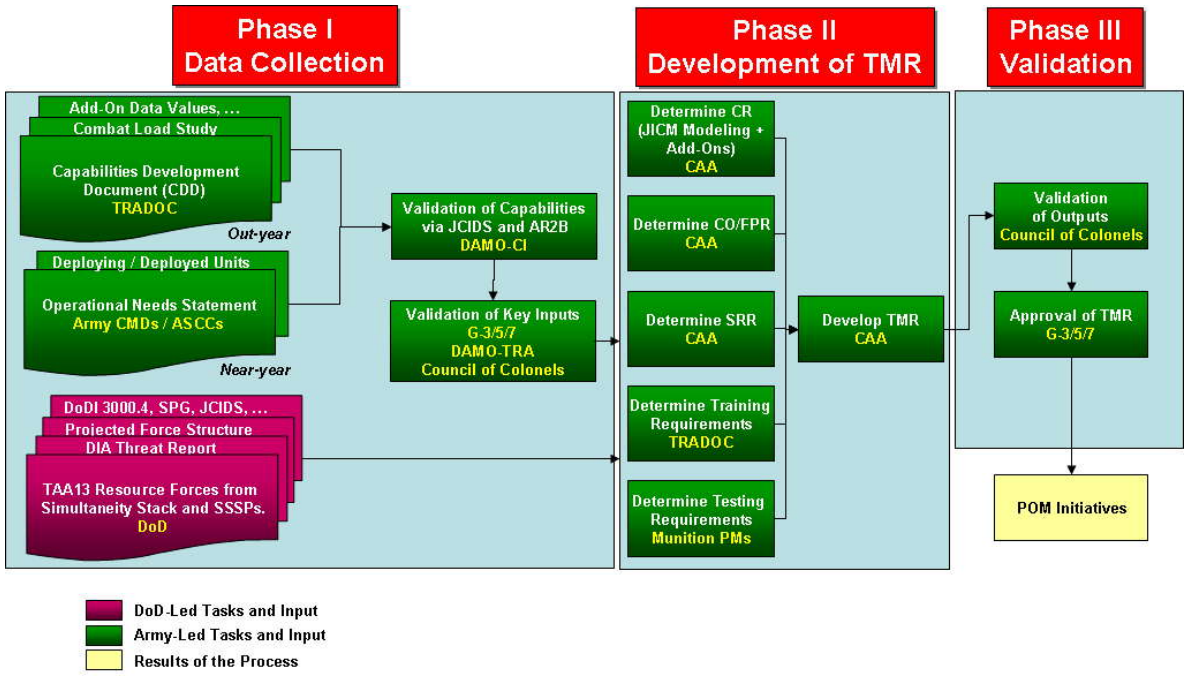

Figure 6-1: US Army MRP[26]

6.2 Phase II – Development of the TMR

The Army TMR generation process is described in Figure 6-2 and is headed by a military analyst, currently a lieutenant colonel billet, at CAA. Once he receives the order to develop the TMR, he requests the Campaign Enablers Division (CED) to obtain the data necessary to support modeling and spreadsheet analysis, such as the add-on factors from TRADOC and updated shooter-target pairing attrition information developed within CED. Once this data is received it is passed to the JICM modeling team within CAA. This team, composed of civilian modeling experts and military personnel to ensure the operational feasibility of the data, develops the necessary WD/SD scenario databases, performs the modeling runs, and generates the results. Upon completion of the modeling runs, the military analyst performs the analysis to determine the CR, CO/FPR, and SRR, then adds the Training & Test requirements provided by TRADOC to determine the TMR.

[26] Note: Figure 6-1 is a conceptual diagram created by the GAR Study Team for illustrative purposes only. It should not be construed as an authoritative representation.

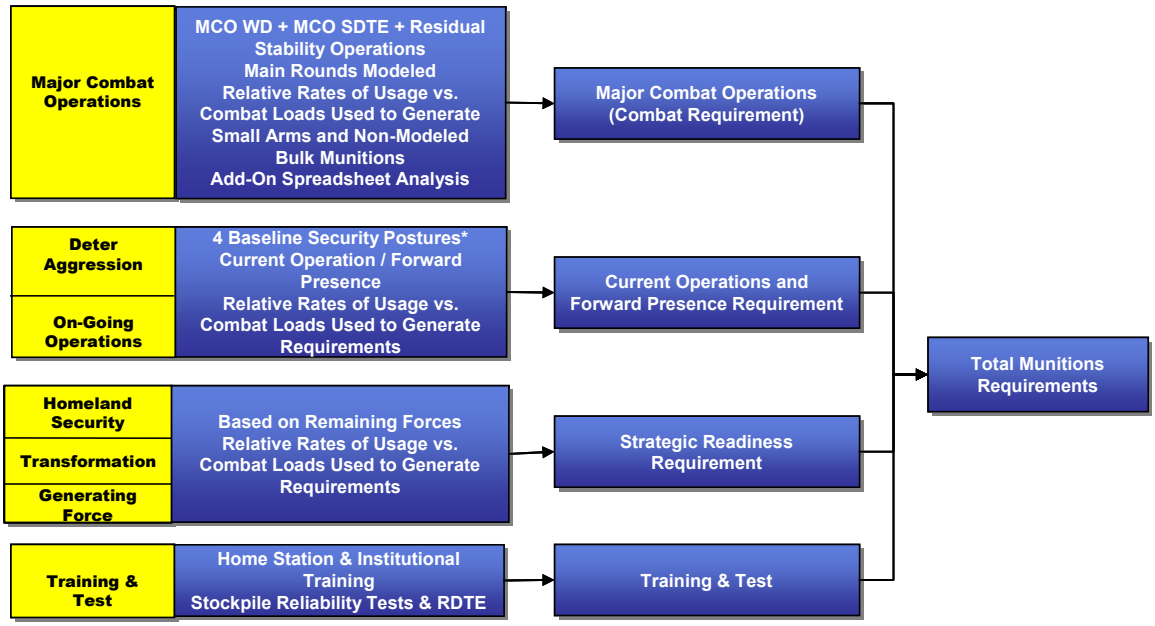

Figure 6-2: US Army MRP Organizational Perspective

6.2.1 Computing the Combat Requirement

The Army's combat requirement for the WD and SD scenarios consists of three components: consumption, theater sustainment, and residual requirements.

To calculate consumption, the Army first categorizes each DODIC as small arms, bulk, or main. Main round expenditures are calculated in JICM. Spreadsheet analysis is performed for seven add-ons, including: munitions losses associated with combat; expenditures against suspect targets; expenditures against support targets (i.e. combat support vehicles)[27]; registration; functional checks; zeroing; and losses occurring in the logistical system. Values supporting these add-on calculations are supplied by TRADOC.

As a combat model, JICM determines expenditures based on a series of force-on-force engagements that are performed when units from opposing sides meet on the battlefield as they maneuver to obtain specified objectives. The flow and interaction of ground units can be influenced by other factors including, but not limited to; air and naval-air strikes against targets; terrain; situational awareness; logistics; and repair. All of these are represented in the model.

When an engagement occurs, JICM uses the CAA-produced Attrition Calibration (ATCAL) methodology to determine round expenditures and losses for both sides. ATCAL uses

[27] The PTD includes a category for combat support vehicles which is used as a direct input into the WRMR model. Thus, this target set is attrited in the target-oriented methodology within the model. Being a campaign-level model, JICM doesn't model the 'ash and trash' of a unit, or all of the supporting vehicles and other assets that are represented in this target set. Thus, the Army must account for expenditures against this target set via a methodology defined outside JICM.

"boards" derived from the Combat Sample Generator Model (COSAGE) runs that define direct fire system rate of fire, system availability, range, probability of kill and probability of K-kill given a kill, as well as indirect-fire system bias, lethality, response, and probability of K-kill given a kill. CAA has recently modified JICM to allow for multiple boards to be used for a single scenario to account for battles with different force structures or battles taking place on different types of terrain.

The JICM results provide the combat requirements for approximately 65 DODICs associated with major end-items. For DODICs not represented in the JICM run, numerous methodologies are used to calculate the expenditures. These are discussed below.

It is possible that some, but not all, types of munitions fired by a system are represented in the JICM model. In this case, the Army estimates expenditures based on the expended percentage of the combat load of the non-represented munition versus the represented munitions, or uses historical expenditure ratios to calibrate the expenditure of non-target-oriented munitions against the expenditure rate of AP/AM munitions as modeled in JICM. For instance, the Army utilizes an add-on factor that is provided to CAA by the Army Infantry Center (USAIC) for obscuration and illumination rounds. Doctrinal expenditure ratios, which are based on historical experience, are used to determine this add-on. Currently, this doctrinal ratio is 70-20-10 for AP/AM, obscuration, and illumination munitions, respectively. Thus, for each round of AP/AM expended by the JICM model, .286 rounds of smoke and .143 rounds of illumination are also assumed to be expended. The USAIC further assumes an equal distribution between white and IR illumination rounds, resulting in an add-on factor of .0715 for each of these rounds. Currently, the Army has no feedback to determine if the methodology is accurate or leads to overstockage or understockage (McLaughlin, October 2007).

For secondary weapons on a given system, such as the machine gun on a tank, an assumption is made that the weapon would expend at approximately the same rate relative to its combat load as the main gun on the tank. For example, the main gun of an M1A2 Abrams tank may have a combat load of 30 HE rounds. A JICM run may indicate that during the scenario the average M1A2 fires 45 HE rounds, indicating that each tank expends 1.5 times a combat load. Hence the expenditures for the 7.62mm machine gun on the M1A2 will be calculated as 1.5 times the combat load of the machine gun.

For the numerous small arms and bulk (grenades, detonation cord, etc.) DODICs that are not represented in the model, the Army estimates expenditures by applying a relative expenditure rate of a subset of munitions represented within JICM versus the combat loads of the non-represented systems. This factor is then applied to the combat load of the small arms/bulk DODICs to determine the requirement.

Once the combat-related expenditures for all DODICs are completed, the Army performs spreadsheet analysis to determine the expenditures and losses associated with seven add-ons. These include:

1. Losses associated with combat – This represents the fractional combat load lost

when a given friendly weapon system is destroyed on the battlefield.

2. Expenditures against suspect targets – This represents expenditures against false targets or previously destroyed targets.

3. Expenditures against support targets – This includes expenditures against infrastructure and combat support vehicles not explicitly portrayed in JICM.

4. Registration expenditures – Similar to the WRMR model calculation, this accounts for rounds required to adjust fire control calculations when indirect-fire weapons are relocated in an operational environment.

5. Functional checks – This represents expenditures associated with verifying operational readiness of a given weapon system.

6. Zeroing – This represents expenditures of small arms to ensure battle-sight accuracy.

7. Losses occurring in the logistical system – This represents munition losses prior to delivery to the intended unit. These could be losses due to enemy operations against the Army's logistical pipeline, mishandling of munitions, spoilage etc.

The sum of the calculated combat requirement and these seven add-ons represents the total consumption requirement for the scenario for Phases II and III. (Phase I of a campaign is called "Deter/Engage" but does not appear to be addressed in the MRP calculations.) The US Army uses historical usage rates experienced in OIF to determine the Phase IV requirements, which are then added to the Phase II/III requirements to determine the total combat consumption requirement.

Theater sustainment represents the ammunition in the logistical pipeline at the conclusion of hostilities. This is calculated by determining the average daily expenditure during Phase III and multiplying by 10. In other words, it is estimated that approximately 10 days worth of ammunition will be stockpiled around the theater at the end of hostilities.

Residual capability is defined as one combat load and is applied to each weapons system remaining at the end of the conflict.

6.2.2 Calculating CO/FPR and SRR

CO/FPR and SRR calculations consist of only consumption and residual requirements. By evaluating the daily expenditure rates of the major weapon systems portrayed in JICM, the Army determines a maximum daily expenditure rate for the weapon systems associated with the forces used in the BSPs. This expenditure rate is then compared to the combat load to develop a factor to be applied to the weapon systems represented in the BSPs.

6.2.3 Calculating the Testing and Training Requirements

Training requirements are supplied by TRADOC and testing requirements are compiled from submissions of each of the test munitions' program development offices.

6.3 Phase III - Validation of the TMR

The Army generates the TMR as the sum of the combat requirement, CO/FPR, SRR, and Training & Test requirements. The results of this TMR are presented to the Council of Colonels for review and validation, before being submitted to the G-3/5/7 for approval.

6.4 Potential USMC MRP Improvements Based on US Army Methods

The GAR Study Team identified three items in the Army methodology that could benefit the Marine Corps MRP. First is the formal establishment and actual use of a Council of Colonels, or similar senior-level oversight committee, to review and validate input data and assumptions as well as the resulting TMR. Second is the use of the Analytical Agenda's Baseline Security Postures (or Steady-State Security Postures) as an authoritative, traceable way to define CO/FP and SR forces. Third is the use of civilian employees to provide continuity and maintain institutional knowledge across successive MRP cycles. The GAR Study Team also evaluated the use of JICM by the Marine Corps to develop the TMR but advises against this course of action as explained in section 6.4.4.

6.4.1 Senior-Level Validation of Input Data and Assumptions and Resulting Requirements

The Army uses a Council of Colonels to validate not just requirements generated via the QWARRM process, but also the data that are inputs into the process. The Army approach provides an early opportunity for senior-level oversight to ensure the information and assumptions underlying the QWARRM process are comprehensive and accurate. The approach also provides for review by the same senior-level body at the end of the process, offering the approving authority confidence in the implementation and the results.

The MCCDC ARO could utilize the Capabilities Development and Integration Board (CDIB) to perform this role. With its roles and responsibilities defined in MCO 3900.15B, signed 5 March 2008, the CDIB membership consists of officers or civilian equivalents in the grade of LtCol/GS14 or above. These personnel represent many of the organizations that have a specific role in the development of the TMR, or a vested interest in the results as it applies to the acquisition process, including TECOM and MARCORSYSCOM. The Director, CDD may designate other members as appropriate, providing the flexibility to adjust membership as required to ensure proper oversight of the MRP. The CDIB reviews and makes recommendations concerning all combat development and integration issues including materiel prior to milestone decisions and prior to Marine Requirements Oversight Council (MROC) decision points. These responsibilities indicate the CDIB would benefit

from maintaining oversight of the MRP as it drives acquisition decisions resulting in approximately half a billion dollars annually.

Whatever organization, be it the CDIB or not, is tasked with an oversight role in the MRP it should: comprise organizations relevant to the MRP and the procurement of munitions; have senior-level leaders represent these organizations; and provide a forum for dissemination and validation of assumptions, data and results throughout the requirements process.

6.4.2 Using SSSPs to Determine CO/FP and SR Force Structure

The four vignettes the Army uses provide a clearly defined force structure that derives from the Analytical Agenda. This means the Army is able to: easily defend the rationale for the forces used in the SR and CO/FPR calculations; align them with the guidance provided in the 2007 precoordination draft of DoDI 3000.4 stipulated for use in the POM-10 process which states that the Analytical Agenda is to be used; and change the requirements in future MRPs as expected Army operations evolve and change.

The Marine Corps methodology, explained in detail in section 4.1.2.5, does not utilize the Analytical Agenda and is instead based on consensus Marine Corps opinion on the forces and level of effort that should be applied to both the CO/FPR and SRR. Previous decisions with regard to CO/FP and SR calculations have not been well documented, leading to a lack of understanding and continuity between MRPs.

It is suggested that the Marine Corps evaluate the SSSPs to determine the vignettes that would satisfy their expected future operational tempo and use the forces defined within these vignettes as the SR and CO/FP required forces. This would provide traceability, defendability, and would more closely align the Marine Corps process with the guidance in the proposed versions 4 and 6 revisions of DoDI 3000.4.

6.4.3 Manpower Continuity and Location

The Army process is dramatically aided by the fact that it integrates into the process civilian personnel that can provide continuity and institutional knowledge between successive MRPs, and that the coordination between the modeling staff and the staff developing the TMR is enhanced by being physically co-located.

The USMC currently has one officer (O-5) and one non-commissioned officer responsible for developing and coordinating its munitions requirements. The three-year duration of assignment to these positions ensure that there will be limited continuity and retention of institutional knowledge from one two-year MRP development cycle to the next.

These two military personnel are supported by an approximately two-person contracted level of effort in the form of the WRMR model development team, which maintains and updates the model's code and data and performs the runs necessary to generate the munitions requirements. This team is located near Philadelphia and therefore is not readily able to

physically participate in the meetings and decision-making process that influence and establish the inputs to the model. Further, the GAR Study Team assessed that this team has historically not performed sufficient detailed analysis of model results prior to approval of the TMR.

In contrast, the Army tasks military officers to provide guidance and ensure that adequate coordination is performed and that the modeling accurately represents the theater's needs. In addition, the civilians, who generate input data, operate the model and analyze the results, are also intimately involved with all aspects of the requirements process, providing the potential to maintain an institutional memory that is invaluable to maintaining a consistent, dependable process as military personnel inevitably transition over time.

The advantage of having a civilian or contractor position supporting the MRP is further amplified when examining the Navy's Non-Nuclear Ordnance Requirements process. OPNAV N81 employs a GS-15 who supports a Navy commander in organizing and developing the NNOR. Over the past 35 years, only three different people have filled this Government post. This continuity has allowed the Navy to maintain a well-defined and effective process even though OPNAV Instruction 8011-9A, the instruction defining the roles, responsibilities and procedures to be followed in the NNOR process, was signed in 1989, 14 years prior to the most recent DoDI 3000.4.

In addition to the continuity provided by the N81 civilian, this person is able to undertake tasks that will support the NNOR process but that are not expected to be completed within a single MRP cycle. An excellent example of this is the development of the Quickplace web site used to organize, maintain, and provide traceability to all instructions, models, and data which support the NNOR process. The current, well-organized version of this web site is the result of years of effort, an effort that would have likely failed if it had been the responsibility of rotatin military officers.

To gain the advantages of approaching the munitions requirements development process more as a coherent analytical effort than a disjointed number-calculating exercise, the Marine Corps should consider assigning or establishing an entity, located in MCCDC, to gain an enduring capability to monitor and support the implementation of the process from end-to-end. Such an entity would understand the roles, responsibilities and contributions of all participants in the entire process. By documenting all decisions made with respects to the TMR, the entity would provide a much-needed degree of transparency into data, tools, assumptions, methods and results to participants and decision-makers alike.

This entity would also enable MCCDC to internally operate the WRMR model to perform analysis tasks and investigate sensitivities and alternative constructs to support decision-makers. Compared to JICM, however, the Marines' WRMR model is relatively easy to use and requires less data. For example, JICM requires formal training for operators, incorporates a unique coding system for rule generation, relies on difficult-to-navigate on-line documentation suite for its numerous domain modules and requires some degree of familiarity with computer science techniques to use effectively. The WRMR model, in contrast, utilizes an intuitive graphic-user interface, portrays only Marine forces and

operations and can be understood and mastered quickly through first-hand experience.

As a consequence, the entity described here need not be as large as the support staff maintained by CAA to set-up and run the tool and perform the critical analysis necessary to ensure that the results portray expected expenditures as accurately as possible.

6.4.4 Use of JICM Unnecessary for USMC MRP

While JICM allows the Army to portray a broad spectrum of military capabilities and operations, it is the opinion of the GAR Study Team that the USMC need not adopt this, nor any other, campaign-level combat simulation to develop its combat requirements. The reasons for this are:

- A combat model would require MCCDC to accurately portray, as determined by the COCOM, not just USMC forces, but also US Army, Navy, and Air Force assets. The level of effort required to support and ensure the COCOM's intent is being accurately represented in the model would exceed MCCDC's current manpower capabilities assigned to modeling activity.

- Maintenance of the combat model's input data would be dependent on the support of the other Services, increasing the risk of inaccuracy if the other Services are not able to provide updated data in a timely manner. For instance, JICM has been modified recently to allow for multiple attrition databases which would alter engagement results based on force structure, terrain, and the like. CAA, however, has been hesitant in providing this data to outside agencies, indicating that the USMC would likely be required to use obsolete data to generate its munitions requirements.

- Although a combat model can support the portrayal of effects-based operations (EBO) such as maneuver and isolation, these effects should already be represented in the COCOM-submitted PTDs. Since the allocation of USMC ground targets in the out-year PTD is directly correlated with the near-year PTD, EBO and maneuver should already be represented here as well.

- The WRMR model has been verified, validated, and accredited for use. The WRMR Model V&V Study Team found that the target-oriented methodologies represented in the model are valid. By incorporating the model changes suggested by the WRMR Model V&V Study Team, as well as the model improvements suggested in this document, the WRMR model should provide expenditures as accurate as those produced in a combat model.

7 Proposed Solutions for the Marine Corps MRP

7.1 Phase I – Data Collection

7.1.1 DoD-Generated Data

The Marine Corps has a limited ability to influence the timeliness or quality of the data produced by DoD-led efforts. Nevertheless, through **active** participation in DoD-coordinated meetings and working groups, such as the MRP Working Group being developed per the proposed versions 4 and 6 revisions of DoDI 3000.4, MCCDC and the Marine Corps should be able to voice their concerns with the process and request to have these problems addressed. In addition, MCCDC should notify the MEFs and MARFORs that also participate in coordination for a number of these products of the importance of this process, encourage them to review the documents in detail to ensure accuracy, and be an active participant in the process.

7.1.1.1 Implementation Guidance

The coordination roles of MCCDC and PP&O in the development of the Implementation Guidance will be dependent on the eventual revision of DoDI 3000.4 which will guide future MRPs. If future Implementation Guidance provides the vignettes from the SSSPs to be used for CO/FP calculations (and SR calculations if an SRR is defined as part of the TMR), MCCDC and PP&O will be required to review the draft version of this guidance to ensure that each scenario includes sufficient Marine Corps forces and is representative of the anticipated mission sets the Marine Corps expects to encounter over the course of the next 5-10 years.

If future Implementation Guidance does not provide detailed guidance regarding CO/FP (and, potentially, SR) forces or scenarios, MCCDC must coordinate with PP&O to more transparently derive and define the force capabilities to support these requirements (see sections 7.1.2.5 and 7.1.2.6).

Link: 4.1.1.1 – Current Methodology for Implementation Guidance (Page 41)

Link: 5.1.1.1 – Problems with and Commentary on Implementation Guidance (Page 68)

7.1.1.2 Threat Reports

Section 5.1.1.2 identified two key problems associated with the DIA TRs: the failure to provide target reconstitution and regeneration rates; and inconsistencies between the theater position and the TRs causing delays in delivery of a final TR.

The COCOMs and the Joint Staff J-8 apply repair rates during the development of the PTD. It is unclear what sources are used by the COCOMs to determine the repair rates or if a consistent set of repair rates is used by all of the COCOMs. Given, however, the fact that

repair rates are accounted for by the COCOMs, MCCDC should not apply repair rates when developing its TMR as this creates an obvious redundancy in targets.

MCCDC should indicate the importance of using standardized and approved repair rate values across the Services at the PTD/MRP Kick-Off Meeting, sponsored by the DoD in September of even-numbered years and attended by the Services, COCOMs, and DIA. MCCDC should encourage DIA to provide this information with all future threat reports.

While there is limited ability for MCCDC or the Marine Corps to resolve differences between the theaters and DIA, MCCDC should verify that MCIA is actively participating in the development, and performing periodic reviews, of the data residing in the JCOFA database. MCCDC should also verify that draft TRs are reviewed, in detail, by both MCIA and the MEFs/MARFORs supporting the COCOMs, and that any discrepancies are documented and provided to both MCCDC and the COCOMs. By participating in and providing guidance to the review process, MCCDC can ensure that the Marine Corps organizations performing detailed reviews of the documents are doing so in a methodical and timely manner. These roles and responsibilities should be clearly defined in MCO 8000.7's successor.

Link: 4.1.1.2 – Current Methodology for the Threat Report (Page 42)

Link: 5.1.1.2 – Problems with and Commentary on the Threat Report (Page 70)

7.1.1.3 Near-Year PTDs

The MRP Working Group coordinated by USD (AT&L) has monthly video-teleconferences which provide a forum for MCCDC to solve previously identified disconnects between COCOM/J-8 PTD assumptions and methodologies and the data and assumptions used in the modeling efforts that produce the TMR. This would include such things as ensuring that the TPFDD of record used to generate the PTD is provided with the PTD, that the Marine rotary-wing aircraft targets be assigned to the Marine or Navy air apportionment class, and that the explanation of the PTD methodology implemented by the COCOM include information on whether and, if so, how repaired assets were accounted for in the PTD.

The MCCDC ARO, in the Comments Matrix submitted in December 2007 for the 2007 precoordination draft of DoDI 3000.4, indicated that DoD should mandate a standardized methodology be used by all COCOMs to develop their respective PTDs similar to the guidance provided to DPA&E with regards to generating the out-year PTDs. Version 6 of the revision of DoDI 3000.4 still does not address this problem, but has removed the guidance that DPA&E must use campaign-level models in generating the out-year PTDs. It is unclear whether the proposed MRP Manual will contain such guidance for either DPA&E or the COCOMs. The MCCDC ARO should continue to request during the MRP Working Group meetings that the COCOMs use a standard methodology.

In addition, the MCCDC ARO should use the MRP Working Group meetings to point out that since the out-year PTD apportionment for ground forces is directly based on the near-

year PTD apportionments defined by the COCOMs, the need for accurate near-year PTDs from each of the COCOMs is critical not just for sufficiency testing, but also for determining the out-year munitions requirements supporting the POM process.

Link: 4.1.1.3 – Current Methodology for Near-Year PTD (Page 42)

Link: 5.1.1.3 – Problems with and Commentary on Near-Year PTD (Page 70)

7.1.1.4 Out-Year PTDs

MCCDC and other Marine Corps organizations relevant to the MRP must do all they can to ensure the COCOMs generate consistent, analytically sound near-year PTDs since, as stated earlier, J-8 WAD uses the near-year PTD apportionments for ground forces in the out-year PTD. MCCDC should ensure all outstanding issues, such as those discussed in section 7.1.1.3 are addressed by the MRP Working Group. MCCDC should also point out to the other members of the MRP Working Group the importance of near-year PTDs on the POM process for Marine Corps ground munitions, and strongly encourage USD (AT&L) to incorporate guidance to the COCOMs on methods they are to use to develop the near-year PTDs. This guidance would help ensure a common set of assumptions and methodologies is used by all COCOMs, increasing the reliability and accuracy of the near-year PTDs.

Link: 4.1.1.4 – Current Methodology for Out-Year PTD (Page 42)

Link: 5.1.1.4 – Problems with and Commentary on Out-Year PTD (Page 71)

7.1.1.5 Analytical Agenda

According to the COCOMs, there is no clear alternative to using the JDS website to obtain the CONPLAN/OPLANs and the supporting theater analysis. Hence, requests for access to all ABLs should be submitted as soon as possible by the ARO to account for the lengthy approval process. MCCDC should also request through the JADM SC that access granted to an organization for a specific ABL be carried forward to any subsequent revisions or updates to avoid additional delays.

MCCDC should also request that the JADM SC define more specific reporting requirements and insist on a set of standards pertaining to the data and analysis included in the ABLs by each of the COCOMs. A uniform set of information across the COCOMs with regards to their ABLs would assist organizations throughout DoD and the Services in utilizing the ABL as the starting point in their analytical efforts.

Link: 4.1.1.5 – Current Methodology for Implementation Analytical Agenda (Page 43)

Link: 5.1.1.5 – Problems with and Commentary on Analytical Agenda (Page 71)

7.1.2 WRMR Model Data

The GAR Study Team suggests that the Marine Corps develop a data maintenance system

similar to that used to support the US Navy's NNOR process. In such an approach, WRMR model data would be categorized and maintained in Excel spreadsheets. These spreadsheets would be posted on a Secure Internet Protocol Router (SIPR) website. Each category would be assigned an appropriate organization within the Marine Corps. This organization would assign SMEs responsible for periodically reviewing and validating the data on-line. The spreadsheets would also be used to maintain a history of changes, providing traceability for all data elements within the WRMR model. As an additional benefit, scripts could be written to allow the automated generation of WRMR model input data directly from these spreadsheets. Section 9.1.2 of this report provides a more detailed examination of this proposed process.

It is important for the WRMR model data be reviewed and validated by senior-level personnel able to focus on the details. The Executive Steering Committee for Ammunition (ESCA) is currently tasked with this responsibility, but is currently staffed by flag-level officers for whom time demands preclude the required detailed review. One approach would be to recharter the ESCA to include colonel-level personnel, similar to the US Army's Council of Colonels. Alternatively, the Marine Corps could evaluate whether the CDIB is an acceptable substitute for the ESCA.

Link: 4.1.2 – Current Methodology for WRMR Model Data Discrepancies (Page 44)

Link: 5.1.2 – Problems with and Commentary on WRMR Model Data (Page 72)

7.1.2.1 TPFDD

It is important to ensure that the TPFDD used during the munitions requirements modeling is consistent with that used by the COCOMs and J-8 WAD during PTD development. MCCDC should utilize the MRP Working Group as a means to emphasize the need for including the TPFDD of record, or other dated force flow documents, with the submission of a PTD. Inclusion of the actual documents would be best. If, however, the PTD submission simply references a specific TPFDD or force flow document, MCCDC should continue to request, via an MCATS tasker, that the MARFORs provide these documents.

Link: 4.1.2.1 – Current Methodology for TPFDD (Page 45)

Link: 5.1.2.1 – Problems with and Commentary on TPFDD (Page 72)

7.1.2.2 JMEM

The GAR Study Team identified no alternative to the current method of transforming JWES output into WRMR model input. In light of the exploratory analysis discussed in section 5.1.2.2, it is suggested that MCCDC press the JTCG/ME to review and provide a detailed description of the methodologies used to calculate the average rounds required per kill by JWES. Further, an independent analysis would be useful in verifying that JWES average rounds required per kill values correlate with its Pk values.

The maintainers of the WRMR model should develop a mechanism that provides traceability to changes not only in the JMEM data but changes to all data throughout the model, including the date of change, previous values, reasons for change, and assumptions that were made in developing the updated values. This would allow traceability to data and its sources, and should allow the model maintainers to more quickly identify outdated data elements or those requiring review.

Given the importance of JMEM values to the WRMR model, MCCDC should ensure it actively participates in JTCG/ME working group meetings, especially in years in which it is found that an important shooter-target pairing is not represented in the JMEM database. Active participation, and personal attendance in the working group meetings, would increase the likelihood that problems noted in the JMEM methodology or data by the Marine Corps would be adequately addressed. The long-term civilian position proposed to support the MCCDC ARO in section 6.4.3 would be an excellent candidate to participate in these meetings as the JMEM data generation process is often measured in years instead of months. The MCCDC civilian would be the best person suited for maintaining an understanding of which target-shooter pairings have been requested, approved, and integrated over time into the final JMEM data set.

The target templates used for indirect-fire attrition calculations should be reviewed and validated. This task should be accomplished in coordination with the COCOMs as required by DoDI 3000.4.

Link: 4.1.2.2 – Current Methodology for JMEM (Page 45)

Link: 5.1.2.2 – Problems with and Commentary on JMEM (Page 73)

7.1.2.3 SME Input

As with the JMEM input data, traceability to the SME input to the WRMR model is currently limited and the development of a database that would track the sources, dates of change, previous values, reasons for change, and assumptions applied during the change in values would be advisable.

With extensive operations over the past number of years in Iraq and Afghanistan, the availability of a large number of SMEs with direct experience in combat and stability operations should allow for more accurate numbers to be generated to support the WRMR model. As noted in Sections 7.2.1.8 through 7.2.1.14, however, care must be taken to ensure that the experiences observed in these conflicts are consistent with the anticipated operational momentum and combat intensity to be experienced in the WD and SD scenarios. It may be detrimental to the WRMR process to include SME-supplied inputs based on operations in Iraq and Afghanistan if these are significantly different from the anticipated operations in the WD/SD scenarios.

Link: 4.1.2.3 – Current Methodology for SME Input (Page 47)

Link: 5.1.2.3 – Problems with and Commentary on SME Input (Page 73)

7.1.2.4 OPLAN Alignment

The use of the MARFORs to provide assistance in the alignment of the WRMR model database with the OPLAN/CONPLAN scheme of maneuver and anticipated timing of phase and posture changes is valid, but the process must be formalized. This could occur either through the assignment of roles and responsibilities to the MARFORs in an updated version of MCO 8000.7, or through the use of an MCATS tasker from MCCDC to the MARFORs.

The OPLAN alignment that is developed must be checked against a COCOM's anticipated timing as represented in the analysis submitted with the Analytical Baseline. Once this is completed, the aligned OPLAN should be submitted to the COCOM, along with a description of the method of operation of the WRMR model, so that the plan can be validated. These steps would allow the USMC MRP to align properly with version 6 of the proposed revision of DoDI 3000.4 which requires the use of the Analytical Agenda, including the theater-produced ABLs, and in maintaining close coordination with the COCOMs during the modeling and analytical stages of the MRP.

Link: 4.1.2.4 – Current Methodology for OPLAN Alignment (Page 47)

Link: 5.1.2.4 – Problems with and Commentary on OPLAN Alignment (Page 74)

7.1.2.5 CO/FP Capabilities

The 2007 precoordination draft of DoDI 3000.4 states in paragraph 5.2.1.2.1 that the USD (AT&L) Implementation Guidance will "define current operations and forward presence missions for each Military Service." It failed, however to indicate whether this definition will define specific scenarios from the vignettes that exist in the SSSPs, or will provide vague guidance allowing the Services to define the specific forces required to satisfy the given guidance. The MCCDC ARO, in comments submitted to DoD pertaining to this version of DoDI 3000.4, requested that the final version of the instruction provide specific scenarios and forces to be used in an effort to maintain consistency across the Services.

In version 6 of the proposed revision of DoDI 3000.4, however, the responsibility for generating the CO/FP forces has shifted to the CJCS in coordination with USD(P), the COCOMs, and the Services. Again, it is not clear whether specific vignettes or forces will be defined, or if the guidance will remain vague allowing flexibility on the part of the Services.

Given the current fluid nature of this task, it is unclear what agency will finally be responsible for the definition of these forces. If CJCS, USD (AT&L), or any other organization outside of MCCDC develops these forces, the MCCDC ARO must be prepared to perform a detailed review to ensure that the forces proposed and their expected utilization in a given scenario accurately reflect anticipated future operations (most likely based on a comparison with historical operations).

If, however, DoDI 3000.4 eventually fails to identify an external organization to define these forces, or if the external organization fails to provide detailed guidance, MCCDC should coordinate with PP&O to develop and document a transparent methodology to produce a reasonable set of forces to perform a representative set of operational missions. In order to align the Marine MRP process more closely with the evolving revision of DoDI 3000.4, MCCDC and PP&O could utilize scenarios within the SSSP that have MSFDs with adequate Marine forces to calculate the CO/FPR instead of using the current force-sizing methodology.

If a re-write of MCO 8000.7 specifically defines the roles and responsibilities of the various Marine organizations in supporting the MRP, the MCCDC ARO should develop an MCATS tasker requesting PP&O's assistance in determining these requirements on an annual basis. This assistance would include defining forces, as suggested in the previous paragraph, as well as the days of assault/sustain expenditures for each force. The final force structure, as well as the methodology and assumptions that were used to develop the given force structure and days of assault/sustain expenditures should be well documented and maintained for future reference.

Link: 4.1.2.5 – Current Methodology for CO/FP Capabilities (Page 48)

Link: 5.1.2.5 – Problems with and Commentary on CO/FP Capabilities (Page 74)

7.1.2.6 SR Capabilities

The MCCDC ARO, in items #1 and #4 of its Comments Matrix pertaining to the 2007 precoordination draft of DoDI 3000.4 which was to guide the Services during their POM-10 TMR development, requested the final version of the instruction state that the Implementation Guidance provided by USD (AT&L) clearly define the forces each Service is to use in determining the SRR. This would ensure consistency across the Services in the development of their anticipated expenditure requirements. If a specific force for each Service is defined in the Implementation Guidance, PP&O will no longer be required to define these forces.

Version 6 of the proposed revision of DoDI 3000.4, however, completely removes any reference to Strategic Readiness capabilities or requirements. Thus, as with CO/FP capabilities, it is unclear not only what organization will define the forces associated with this requirement, but whether the requirement will continue to exist at all.

If no external organization is tasked to define the forces, and the SRR remains a part of the TMR, MCCDC must be prepared, as in the case of the CO/FP capabilities discussed above, to request the assistance of PP&O in determining the forces as well as the number of days of assault/sustained operations anticipated in order to generate the SRR

Link: 4.1.2.6 – Current Methodology for SR Capabilities (Page 48)

Link: 5.1.2.6 – Problems with and Commentary on SR Capabilities (Page 75)

7.2 Phase II – Execution of TMR

7.2.1 Compute Combat Requirements

7.2.1.1 Target-Oriented Munitions Expenditures

WRMR Model Equipment Repair Calculations

From the personal experience of a key member, the GAR Study Team knows that USFK applies repair rates within its models for enemy forces when developing its near-year PTD. CENTCOM also confirmed that repair is accounted for in its PTD, while PACOM indicated that repair was not an issue with regard to USMC targets in its PTD. Accounting for repair means that the values in the PTD represent both targets that have been destroyed on first strike as well as equipment that has been repaired and returned to the battlefield and, therefore, constitutes additional targets for subsequent strikes. To avoid double-counting, the WRMR model should apply a recovery rate multiplier of 0 to all enemy equipment. For the MRP supporting the POM-10 process, this suggestion was approved. Although the study was not chartered to perform a direct comparison between the POM-10 TMR as generated by a WRMR model version that excluded repair and the results from a version that followed the historical pattern of including repair, the sensitivity analysis discussed previously in Table 5-1 of this document establishes that the impact of this change has the potential to be significant. It is unclear, however, whether the COCOMs will continue to account for repairs. In the event that future PTDs do not account for repair the WRMR model should be adjusted to more accurately portray repair of enemy ground equipment.

To avoid situations where improbable equipment repair and return rates could significantly inflate munitions expenditures, the GAR Study Team suggests the WRMR model be modified to account for realistic logistical and repair capabilities on the part of an enemy. The model developer should provide a switch which would activate or deactivate repair calculations within the model.

To improve the modeling of the enemy's repair capabilities, a maximum repair rate per day for each type of equipment for each scenario should be defined within the WRMR model database. The model would then place all repairable targets into a 'bin', with only this maximum being returned to service each day. The targets within the bin would be counted as destroyed for purposes of phase- and scenario-completion calculations.

Finally, to account for the effects of the destruction of the enemy's repair capabilities over time, two piecewise linear curves[28] could be used to affect the probability of repair and duration of repair based on time. The first curve could be defined as Day vs. Probability of Repair Multiplier, with the second element being a number between 0.0 and 1.0. The second curve could be defined as Day vs. Repair Duration Multiplier, with the second element between between 1 and a large number, perhaps limited to the length, in days, of the campaign. These curves could be assigned by type of equipment to account for the enemy's inability, or limited ability, to repair select weapons, or the enemy maintaining a robust infrastructure to repair other types of equipment.

> Example: Suppose the user has selected to include weapon repairs in the WRMR model and has defined the following two degrade curves for tanks, which initially have a probability of recovery and repair of 0.5 and duration of 6 days to repair:

```
P(repair) Degrade Curve = (1, 1.0) (10, 0.1) (11, 0.0)
Repair Duration Multiplier = (1, 1.0) (5, 2.0) (10, 10.0)
```

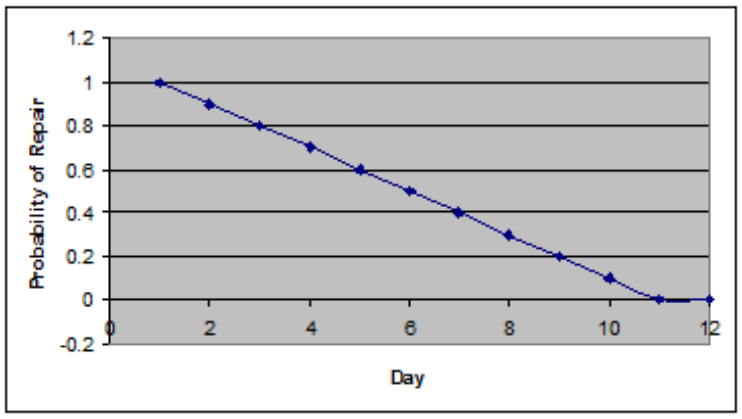

Figure 7-1: Sample P(repair) Degrade Curve

[28] A piecewise linear curve is a curve defined on a sequence of intervals with the values between these intervals being calculated by linear interpolation between the two endpoints.

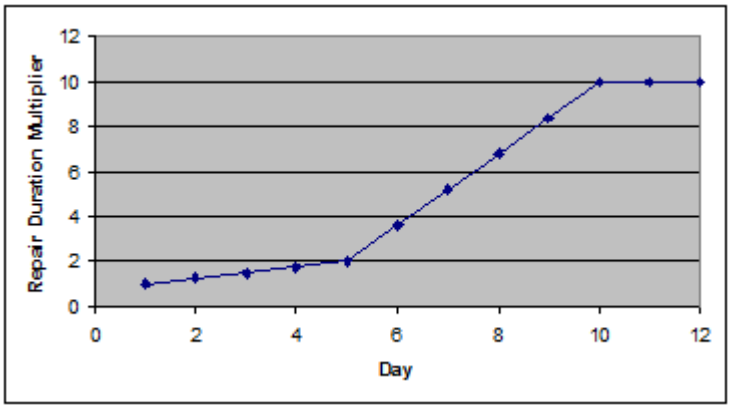

Figure 7-2: Sample Repair Duration Multiplier Curve

A tank that is struck on day 1 of the campaign would still have the initial probability of recovery and repair and days to repair. A tank struck on day 5, however, would have its probability of recovery and repair multiplied by 0.6 – the linear degrade between 1 at day 1 and .1 at day 10 – for an overall probability of repair of 0.3. The duration of the repair would increase to 12 days, 2.0 times the original 6 days.

This proposed modification allows for the WRMR model to account for the cumulative effects of the stress to the logistical and repair capabilities of the enemy as the Army, Air Force and Navy degrade the logistical infrastructure and repair facilities as well as strike equipment in addition to the USMC-only kills represented in the model. It satisfies this requirement while maintaining a similar level of fidelity experienced throughout the rest of the model.

WRMR Model Friendly Force Attrition Methodology

Loss exchange data should be readily available from the theater-specific ABLs and PTDs. During the PTD/MRP Kick-off Meeting, USMC representatives should request that each COCOM provide this data based on their modeling results. This, along with OPLAN alignment, would synchronize the WRMR model with the results generated for each theater.

Target clumping

Modifying the WRMR model to account for a fluctuating enemy target set over a phase is a more complex undertaking than the other proposed modifications. It is critical that any changes to the model improve fidelity, but limit the additional complexity of the input data. The objective of such a modification would be to more accurately align the timing of the arrival and utilization of USMC forces with their anticipated roles as defined in the theater OPLANs without attempting to convert the WRMR model into a detailed, campaign-level

combat simulation. One possible solution would be to define for a campaign phase a percentage of targets which are to be destroyed in a given battle phase.[29] Theater planners would likely be able to provide insight and data to support this effort, removing the current user-defined 80/20 parameters that are not derived from an authoritative source. Again, however, this is only a proposed solution. Difficulties in implementing this simplistic solution may arise, requiring alternative methods to be developed to address this problem. Any final solution would obviously have to be coordinated through the MCCDC ARO and the WRMR model development team.

User-Defined Data Values for Suppressive Fires

As noted in section 4.2.1.1, the same values are used for all munitions used to perform suppressive fires. These values generate an approximate 10:1 ratio of suppressive fires to target-oriented fires, which may be excessive for some weapon systems. Thus, it is recommended that this data be reviewed and validated.

Link: 4.2.1.1 – Current Methodology for Calculating Target-Oriented Expenditures (Page 50)

Link: 5.2.1.1 – Problems with and Commentary on Target-Oriented Expenditures (Page 75)

7.2.1.2 Illumination and Obscuration Expenditures

While utilizing historical data, as was used for the POM-10 TMR and discussed in section 5.2.1.2, for these calculations is acceptable, it assumes an inherent risk of failing to account for changes in munitions, sensors, platforms, operational concepts, training and command and control that may significantly affect the employment of any given munition. For instance, the development and use of night-vision equipment has undoubtedly significantly altered the use of illumination rounds in comparison to the procedures in force during World War II and the Korean War. A periodic review of historical usage coupled with trend analysis is necessary in order to ensure munitions requirements derived from this process remain relevant and accurate.

In the opinion of the GAR Study Team, it would be best to modify the current calculation within the WRMR model. This would ensure that changes in munitions capabilities or employment procedures could be accurately portrayed immediately and avoid the influence of historical data representing obsolete equipment or practices. One possible solution is proposed below:

Step 1. *Determine the total minutes of obscuration/illumination required per*

[29] The WRMR model allows the user to define phases of the war (Phase I – Deter/Engage, Phase II – Seize the Initiative, etc.) which are then broken down into sub-phase, or battle phases, which define the posture of the Marine Corps forces at various times throughout the phase. It would be possible to test the suggested modification by developing a one-to-one correspondence between phases and battle phases, effectively disassociating the phases from the phases as defined in the OPLANs.

engaged infantry company per day.

Step 2. *Determine the possible contribution, defined as the percentage of total minutes of obscuration/illumination possible by all weapon systems, for each available weapon system based on the quantity of each system available, the number of illumination rounds available in each system's combat load, and the number of minutes of illumination per round.*

Step 3. *Use this percentage to determine the total number of "responsible" minutes for each weapon system.*

Step 4. *Divide the responsible minutes for each system by the minutes of illumination of each systems' rounds to determine the unconstrained rounds.*

Step 5. *Limit the final constrained rounds by the total number of rounds available based upon combat loads.*

Example: Assume two engaged infantry companies require 60 minutes each of illumination, for a total demand on the supporting weapon systems of 120 minutes of illumination per night.

Step	Method	60mm Mortar	81mm Mortar	155mm Howitzer	Notes
1.	Qty of Systems	6	2	1	
2.	Combat Load	8	18	6.67	
3.	Min. of Illum / Round	.67	.67	2	
4.	Total Rounds Available	48	36	6.67	Line 1 x Line 2
5.	Total Minutes Available	32	24	13.33	Line 3 x Line 4
6.	% of Total Min. Avail.	46.2%	34.6%	19.2%	Line 5 / Sum(Line 5)
7.	Responsible Minutes	55.4	41.5	23.1	Line 6 x 120 minutes
8.	Unconstrained Rounds	82.7	61.9	11.55	Line 7 / Line 3
9.	Constrained Rounds	48	36	6.67	Max (Line 2, Line 8)

Table 7-1: Sample of Proposed Obscuration/Illumination Methodology

In this particular example, the systems available in-theater are not sufficient in number to provide the level of illumination support required by engaged infantry forces. This forces the available systems to fire their entire combat load. If the number of required minutes were halved, the 60mm mortar, 81mm mortar and 155mm howitzer would fire approximately 41.3, 31.0, and 5.7 rounds, respectively, which is proportional to the capabilities of each system based on quantity and quality, as measured in duration of illumination per round.

This proposed solution rectifies the two major flaws found in the current implementation. First, the SME-supplied data elements are removed from the individual smoke/illumination systems and a single infantry company requirement for daily smoke/illumination minutes is used. This single data point could initially be calculated by dividing the total smoke/illumination expenditures during major combat operations in OIF by the average number of infantry companies that were engaged. Second, it automatically adjusts the results based on the weapon systems that are available to provide support to the infantry companies. The proportion of rounds fired between systems will also be dependent upon the quantity of each type of system in theater, something that is not currently accounted for in the WRMR model. Thus, it resolves these errors and reduces the amount of SME-supplied data while maintaining a level of fidelity that is consistent with the other calculations in the WRMR model.

Assessing the quality of this new methodology is difficult, especially when the modification has not been integrated into the model. It is also difficult to perform comparisons with the version of the model and database used to generate the POM-10 TMR given that last minute changes to the model incorporated a smoke/illumination expenditure rate defined as a fraction of the target-oriented expenditures of the firing systems. Finally, assessment is difficult because the SME input to support this methodology has not been requested. It is possible, however, to use the currently defined minutes of illumination required per infantry company per day by supporting weapons system and the model output data defining forces and weapons available on a daily basis to perform a rudimentary analysis on this new methodology. By integrating these data points into an Excel spreadsheet and Visual Basic application, it was found that the new methodology would reduce the unconstrained requirement by nearly 15%.

Regardless of the methodology that is eventually implemented in the WRMR model, it is imperative that the resultant expenditures be assessed against historical data as a benchmark. The GAR Study Team was able to find three separate sources of historical smoke and illumination data, including munitions expended during the Gulf War and OIF, and a more detailed account of the expenditures during the Battle of An Nasiriyah. Obviously, the time periods and combat intensities varied significantly between each data set. Nevertheless, this historical data can provide some guidance and assist in bounding the estimates of obscuration and illumination munitions expenditures.

The Gulf War data illustrates expenditures of 155mm howitzer munitions for the nine artillery battalions under command of the 10th and 11th Marine Battery HQs between 17 January and 28 February 2001.

	Firing Units									
	2/10	3/10	5/10	2/12	1/11	3/11	5/11	1/12	3/12	
Munitions Type	**Rounds Fired by Type by Unit**									**Total Rounds Fired**
AP/AM	1286	1671	1271	1794	488	630	758	679	757	9334
ILL	127	22	49	4	18	10	4	37	0	271
SMK	139	0	82	0	0	0	0	0	4	225
	Percentage of Total Rounds Fired by Unit									
AP/AM	82.9	98.7	90.7	99.8	96.4	98.4	99.5	94.8	99.5	95.0
ILL	8.2	1.3	3.5	0.2	3.6	1.6	.5	5.2	0	2.8
SMK	8.9	0.0	5.8	0.0	0.0	0.0	0.0	0.0	0.5	2.3

Table 7-2: Artillery Expenditures of 10th and 11th Marine Battery HQ Forces, January 17 – February 28, 2001

Table 7-2 above indicates that obscuration (smoke) and illumination rounds both account for approximately 2-3% of all rounds fired. Unfortunately, it provides no insight into mortar expenditures.

In addition, MARCORSYSCOM provided data pertaining to USMC expenditures in Iraq from March 2003 through March of 2007. The information presented in Table 7-3 below is a subset of this comprehensive data, representing the initial battle for Iraq and the subsequent period of sporadic high-intensity combat, such as the first and second Battles for Fallujah in April and November of 2004 and low-intensity counter-insurgency operations.

		Dates of Action		
		03/03-04/04	**05/04-03/05**	
Weapon System	**Munitions Type**	**Number of Rounds Fired**		**Total**
60mm Mortar	AP/AM	6148	16033	22181
	ILL	1051	5118	6169

	SMK	0	2037	2037
81mm Mortar	AP/AM	12886	20276	33162
	ILL	3454	4771	8225
	SMK	7061	1377	8438
155mm Howitzer	AP/AM	29091	9819	38910
	ILL	0	969	969
	SMK	631	796	1427
Weapon System	**Munitions Type**	**Percentage of Total Rounds Fired**		**Total**
60mm Mortar	AP/AM	85.4	69.1	73.0
	ILL	14.6	22.1	20.3
	SMK	0.0	8.8	6.7
81mm Mortar	AP/AM	55.1	76.7	66.6
	ILL	14.8	18.1	16.5
	SMK	30.2	5.2	16.9
155mm Howitzer	AP/AM	97.9	84.8	94.2
	ILL	0.0	8.4	2.3
	SMK	2.1	6.9	3.5

Table 7-3: USMC Artillery Expenditures in Iraq, March 2003 - March 2005

The information in Table 7-3 above is limited in that it represents but a single campaign. It does, however, represent a mix of high-, mid-, and low-intensity conflict levels in urban environments as well as in open country. It is the most comprehensive data acquired by the GAR Study Team for illustrating the role of obscuration and illumination in recent warfare as characterized by the maneuver capabilities and night-vision systems available to modern US forces. It is important to consider how significantly these capabilities and systems have

changed the face of US operations from the way in which past wars were prosecuted, and it is important to note that the usage of smoke and illumination rounds in Phase IV stability operations is much greater than that experienced during major combat operations. In this context, the GAR Study Team submits that the above information could be envisioned as a reasonable standard for estimating obscuration (smoke) and illumination expenditure percentages in WD/SD scenarios.

Major Walker Field presents an additional data point in his article, Marine Artillery in the Battle of An Nasiriyah, which appeared in the November-December 2003 issue of *Field Artillery*. Again with the caveat that the scope of a single battle is inappropriate for Corps-level munitions expenditure calculations, Major Field indicates that of all rounds fired by the 1/10 Artillery Battalion in support of military operations in urban terrain (MOUT), only 1% were smoke and 1% were illumination rounds.

Until an improved methodology can be integrated into the WRMR model it is suggested that the AP/AM:Illumination: Smoke ratios found in Table 7-4 be used to determine each of the systems' smoke and illumination requirements. The values in this table represent the maximum expenditure rates of obscuration and illumination munitions during the two time periods shown in Table 7-3. Given the lack of traceability of the derivation of the Army's 70:20:10 ratio, it is suggested these values not be used.

Weapon System	AP/AM	Obscuration	Illumination
60mm Mortar	69%	9% (.13)	22% (.32)
81mm Mortar	52%	30% (.58)	18% (.35)
155mm Howitzer	85%	7% (.08)	8% (.09)

Table 7-4: Suggested interim relative expenditure rates (with AP/AM multiplier in parentheses).

(Note: For the MRP supporting POM-10, the values above were used to determine obscuration and illumination expenditures.)

Link: 4.2.1.2 – Current Methodology for Calculating Illumination/Obscuration Expenditures (Page 54)

Link: 5.2.1.2 – Problems with and Commentary on Illumination/Obscuration Expenditures (Page 80)

7.2.1.3 Rear-Area Security Expenditures

Based upon the problems with rear-area security expenditures described in section 5.2.1.3, it is suggested that the WRMR model's rear-area security calculation be modified and performed for every weapon type as follows:

(Daily rear-area security expenditures) = (Rear-area episodes per day)(Rounds Per Episode)

This formula provides a number of advantages over the current calculation. First, this method is more consistent with how rear-area security actually works. It accounts only for the rounds being expended during rear-area engagements, and does not corrupt this data by trying to allocate expenditures across all the weapons that are present in the rear-area.

The SME-supplied values for rear-area episodes per day and rounds per episode data are obtainable from historical sources. For instance, it is possible to utilize recent OIF data from the Small-Arms Incident Database in Iraq to determine a valid number of expected episodes per day as well as rounds per episode. The current situation in Iraq is very similar to possible rear-area security situations in other theaters during combat operations. Platoon- to company-sized engagements are occurring throughout the theater, with primarily small arms fire being exchanged.

Finally, this methodology is consistent with those used in other areas of the WRMR model, including the calculations for mine and explosive ordnance disposal expenditures as well as operational check, registration and zeroing expenditures which basically calculate requirements as the product of 'episodes per day' and 'expenditures per episode.'

The data supporting this calculation should be adjustable by theater. This is important as some theaters would be expected to have a much greater rear-area threat than others. North Korea, for instance, maintains tens of thousands of special operations forces designate to penetrate into the rear-area prior to and during hostilities. Other theaters may expect insurgencies, while other theaters may anticipate limited rear-area threats.[30]

Link: 4.2.1.3 – Current Methodology for Calculating Rear-Area Security Expenditures
(Page 55)

Link: 5.2.1.3 – Problems with and Commentary on Rear-Area Security Expenditures
(Page 81)

7.2.1.4 Self-Defense Expenditures

Self-defense expenditures for non-GCE weapons appear to be double-counting expenditures already represented in the rear-area security calculation. A method is required, however, to account for GCE weapons that aren't accounted for in the target-based expenditure methodology. Therefore, a mixed-solution to account for the self-defense category of expenditures is required. The WRMR model data should be evaluated to ensure that non-GCE weapon systems expending ammunition in the rear-area security module, and GCE weapons expending in the target-based calculations are not also represented in the self-defense category.

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[30] It is unclear what the magnitude of impact of the proposed methodological change would produce without implementing the change and incorporating all of the supporting data. Justification for the proposed methodological change, however, rests in the fact that the current methodology utilizes data that is difficult to estimate as it accounts for all non-GCE weapons instead of only the weapons that are normally used to engage the enemy in the rear area.

In addition, the expenditure rates for all weapons defined in the self-defense module should be reviewed. Two values currently in the WRMR model database are clearly overstated. Weapons capable of chambering DODIC A260, which refers to 9mm Jacketed Hollow Point munitions, are declared to fire at a rate of 600 rounds per weapon per day. Fortunately, this DODIC is not currently assigned to any weapons in the WRMR model and appears as a training-specific munition type.

DODIC A475, which refers to the Cartridge, Caliber .45 Ball M1911 munitions, is declared to be expended at a rate of 200 rounds per weapon per day. During model execution, this expenditure rate will be reduced to the equivalent of one combat load, or 54 rounds per day, but will still create a combat requirement of 278,262 rounds for the 44 weapons that are in theater. Given that most other munitions are expended at only 1-3% of their combat load per day in self-defense, it seems clear that a 100% expenditure rate every day in theater is vastly overstating the requirement for this DODIC.

As noted earlier, having a data element based on the number of rounds expended per weapon per day, especially for weapons that are not an integral part of normal combat operations, requires additional effort on the part of the analyst to ensure that the final requirement is reasonable.

Link: 4.2.1.4 – Current Methodology for Calculating Self-Defense Expenditures (Page 55)

Link: 5.2.1.4 – Problems with and Commentary on Self-Defense Expenditures (Page 82)

7.2.1.5 Operational Check Expenditures

To ensure flexibility, this variable representing the frequency of required operational checks should be extracted from the code and placed in a user-modifiable data file such as *param.in*.

Link: 4.2.1.5 – Current Methodology for Calculating Operational Check Expenditures (Page 56)

Link: 5.2.1.5 – Problems with and Commentary on Operational Check Expenditures (Page 82)

7.2.1.6 Registration Expenditures

As shown by the large 60mm mortar registration expenditures compared to its target-oriented expenditures in Table 5-5, SME-supplied input parameters must be constantly evaluated and updated to ensure accurate and reliable results are being obtained from the model.

Link: 4.2.1.6 – Current Methodology for Calculating Registration Expenditures (Page 57)

Link: 5.2.1.6 – Problems with and Commentary on Registration Expenditures (Page 82)

7.2.1.7 Logistics Losses

The GAR Study Team believes that the methodologies used to calculate these expenditures within the WRMR model are valid; therefore, no changes are required. It is recommended, however, that the SME-supplied values be reviewed on a regular basis to ensure that the data is consistent with current tactics, training, and procedures (TTP).

Link: 4.2.1.7 – Current Methodology for Calculating Logistics Losses (Page 57)

Link: 5.2.1.7 – Problems with and Commentary on Logistics Losses (Page 83)

7.2.1.8 Demolition Expenditures

The GAR Study Team believes that the methodologies used to calculate these expenditures within the WRMR model are valid; therefore, no changes are required. It is recommended, however, that the SME-supplied values be reviewed on a regular basis to ensure that the data is consistent with current tactics, training, and procedures (TTP).

Link: 4.2.1.8 – Current Methodology for Calculating Demolition Expenditures (Page 58)

Link: 5.2.1.8 – Problems with and Commentary on Demolition Expenditures (Page 84)

7.2.1.9 Mining Expenditures

The GAR Study Team believes that the methodologies used to calculate these expenditures within the WRMR model are valid; therefore, no changes are required. It is recommended, however, that the SME-supplied values be reviewed on a regular basis to ensure that the data is consistent with current tactics, training, and procedures (TTP).

Care should be taken, however, when trying to apply data based on OIF and Afghanistan. OIF expenditure rates for mining do not provide a valid historical estimate for determining the accuracy of the SME-supplied values given that combat operations in the WD/SD scenarios used to determine munitions requirements could be significantly different than what was experienced during OIF.

Link: 4.2.1.9 – Current Methodology for Calculating Mining Expenditures (Page 58)

Link: 5.2.1.9 – Problems with and Commentary on Mining Expenditures (Page 84)

7.2.1.10 Zeroing Expenditures

The GAR Study Team believes that the methodologies used to calculate these expenditures within the WRMR model are valid; therefore, no changes are required. It is recommended, however, that the SME-supplied values be reviewed on a regular basis to ensure that the data is consistent with current tactics, training, and procedures (TTP).

Link: 4.2.1.10 – Current Methodology for Calculating Zeroing Expenditures (Page 59)

Link: 5.2.1.10 – Problems with and Commentary on Zeroing Expenditures (Page 84)

7.2.1.11 Screening Expenditures

The GAR Study Team believes that the methodologies used to calculate these expenditures within the WRMR model are valid; therefore, no changes are required. It is recommended, however, that the SME-supplied values be reviewed on a regular basis to ensure that the data is consistent with current tactics, training, and procedures (TTP).

Given the rapid advance of American forces and limited resistance by Iraqi heavy forces, OIF expenditure rates for screening munitions likely do not provide a valid historical estimate for determining the accuracy of the SME-supplied values for combat operations in the WD/SD scenarios used to determine munitions requirements.

Link: 4.2.1.11 – Current Methodology for Calculating Screening Expenditures (Page 59)

Link: 5.2.1.11 – Problems with and Commentary on Screening Expenditures (Page 84)

7.2.1.12 Command & Control Expenditures

The GAR Study Team believes that the methodologies used to calculate these expenditures within the WRMR model are valid; therefore, no changes are required. It is recommended, however, that the SME-supplied values be reviewed on a regular basis to ensure that the data is consistent with current tactics, training, and procedures (TTP).

Link: 4.2.1.12 – Current Methodology for Calculating Command & Control Expenditures (Page 59)

Link: 5.2.1.12 – Problems with and Commentary on Command & Control Expenditures (Page 85)

7.2.1.13 EOD Expenditures

The GAR Study Team believes that the methodologies used to calculate these expenditures within the WRMR model are valid; therefore, no changes are required. It is recommended, however, that the SME-supplied values be reviewed on a regular basis to ensure that the data is consistent with current tactics, training, and procedures (TTP).

As opposed to mining and screening expenditures, operations in Iraq and Afghanistan should provide more accurate EOD values as input to the WRMR model.

Link: 4.2.1.13 – Current Methodology for Calculating EOD Expenditures (Page 60)

Link: 5.2.1.13 – Problems with and Commentary on EOD Expenditures (Page 85)

7.2.1.14 Ancillary Item Expenditures

The GAR Study Team believes that the methodologies used to calculate these expenditures within the WRMR model are valid; therefore, no changes are required. It is recommended, however, that the SME-supplied values be reviewed on a regular basis to ensure that the data is consistent with current tactics, training, and procedures (TTP).

Link: 4.2.1.14 – Current Methodology for Calculating Ancillary Item Expenditures (Page 61)

Link: 5.2.1.14 – Problems with and Commentary on Ancillary Item Expenditures (Page 85)

7.2.2 Compute Combat Planning Factors

Issues and proposed solutions regarding development and distribution of WRMR model-generated CPFs are detailed in section 8 of this report.

To address the issue of the WRMR model providing a CPF of zero for DODICs that have no expenditures for more than half of the days of a scenario, it is recommended that a methodology similar to that used by the WRMR model for calculating the CPF be used, disregarding the zero expenditure days. In other words, the model would determine the knee in the curve for all non-zero days of expenditure. The portion of non-zero days above this knee would be averaged to determine the assault CPF, while the average of the non-zero days below this knee would determine the sustained CPF. In cases where no identifiable knee is present, the assault and sustained rates of fire would be equal.

Link: 4.2.2 – Current Methodology for Computing Combat Planning Factors (Page 61)

Link: 5.2.2 – Problems with and Commentary on Computing Combat Planning Factors (Page 85)

7.2.3 Compute CO/FPR and SRR

The GAR Study Team determined, as discussed in section 8 of this report, that the WRMR model generates valid CPFs. Provided accurate force structure and days of assault/sustained rates of expenditures are available to support these calculations (see sections 7.1.2.5 and 7.1.2.6), the current methodology for computing CO/FP and SR requirements is valid.

Link: 4.2.3 – Current Methodology for Computing CO/FPR and SRR (Page 63)

Link: 5.2.3 – Problems with and Commentary on Computing CO/FPR and SRR (Page 86)

7.2.4 Determine Training Requirement

7.2.4.1 Compute Training Requirements

In an effort to define a training requirements process that is based on a solid analytical

underpinning that resolves the issues presented in the NAS report, TECOM initiated a two-phase approach. The first phase consisted of a nearly two-month study to perform preliminary research, gather and analyze data, and develop a requirements document for a Training Ammunition Model. TECOM's Study Team examined methods used by the Army and Navy in an effort to incorporate the best practices of each of these Services. The final deliverable was provided to TECOM on 27 December 2007.

The second phase, under way at the time of this report, was chartered to "propose a viable structure and methodology for a predictive tool for USMC training ammunition usage" (HQMC, 2008). This was to be accomplished through comprehensive analysis of historical usage data and current requirements to identify unit-by-unit fluctuations over a specified period of time. The historical usage was to be compared with the training ammunition expenditure planning factors, with disparities to be identified and investigated. The result was to be a course of action for producing a predictive model to generate realistic training ammunition requirements.

The Phase 1 TECOM Study Team suggested modifying the Marine Corps Training Information Management System (MCTIMS) database to integrate T&R Manual requirements along with a training plan to generate the sustainment training munitions. Thus, sustainment requirements for each DODIC would be calculated by multiplying the number of personnel requiring training, the rounds required to train by event, as defined in the T&R Manuals, and the refresh interval.

The Phase 1 TECOM Study Team noted a number of challenges that must be overcome to produce such a tool. Primary among them is the fact that many of the data sources, such as the T&R Manuals, Event Guides, and Programs of Instruction are only available in document form, as opposed to database or spreadsheet. Similarly, Training Input Plans are currently only viewable via a MCTIMS report. In addition, the format and the degree to which ammunition requirements are documented in the T&R Manuals are not consistent.

To resolve these issues, the Phase 1 TECOM Study Team proposed three separate courses of action. The first is manual extraction of necessary data from the required documents. The second course of action would utilize MCTIMS database query capabilities to generate spreadsheets or databases that would feed the training ammunition allowances definition process. The final course of action would link the training ammunition allowance definition process directly to MCTIMS via a database server. The Phase 1 TECOM Study Team's Task 3 – Data Analysis Report identified the requirements for each of these courses of action and provides a comparative analysis of the three options. The Phase 1 TECOM Study Team recommended implementation of the second option as it eliminates potential errors that can be introduced in the existing manual date entry process, could be completed faster than option three, and would be more responsive to changes in training and readiness doctrine. (Northrop Grumman, 2007b)

Using the T&R Manuals will likely result in an increase in the total training munitions requirement. However, the requirement will be based upon a solid analytical foundation, and will be readily traceable to the individual elements that comprise it. When combined with

the four other components of training, the total training munitions requirement will represent the maximum expected peacetime training requirement, with all Marine Corps units available to train to the standards as defined in the T&R Manual. This unconstrained requirement will be compliant with DoDI 3000.4 which states that unconstrained requirements may be limited by logistical or production limitations, but not by budgetary constraints.

As already noted in TECOM's process review, peacetime training ammunition requirements are significantly different than those during wartime. In addition, non-combat operations such as humanitarian missions can also significantly alter the overall training requirements. The GAR Study Team suggests that TECOM consider applying lessons learned from the Army's munitions requirements process and provide both its unconstrained training munitions requirement, as well as a 'critical requirement' which would be the unconstrained requirement multiplied by the quotient of historical training expenditures to the historical unconstrained allowance. This critical requirement represents the minimum requirement which must be available to ensure that units maintain the ability to train to standards. Given the fact that the new requirements process will produce significantly different allowances, the historical expenditures:allowance quotient must be calculated using the new methodology implemented by TECOM. If sufficient historical data exists, it is further suggested that trend analysis instead of historical averages be utilized in performing the above calculations. This will allow for increased accuracy as weapons systems are introduced or removed from the Marine Corps inventory, increasing or decreasing the associated munitions requirements over time.

Since the baseline training requirement defines all training rounds required regardless of the geographic location of the units performing the training, training expenditures by deployed units should not be added to the CR, CO/FPR, or SRR.

In addition to the training munitions requirements, TECOM should provide MCCDC a short briefing explaining the methodology, assumptions (including ammunition substitutions and operational deployments included which would impact the TTR), forces, and other relevant decisions and data that were used in the compilation of the requirement. The development of this briefing would provide TECOM and MCCDC the ability to review and verify all data inputs and assumptions, analyze the resultant training requirements, and organize this information in such a manner as to ensure that, when briefed to a senior-level oversight body, that this committee would have all data necessary to understand the process and data involved, and approve the training requirements submission.

Historical Analysis of Training Munition Expenditures And Relationship to the Critical Requirement

When developing the critical requirement based on historical expenditures, TECOM should not utilize an aggregate or weighted-average approach to develop a single multiplier to all munition types. This point is raised for three reasons: a weighted-average approach was used to calculate the PPL although the delivery times for munitions varies, leading to erroroneous results; during interviews with TECOM and MARCORSYSCOM personnel it

was repeatedly stated that training expenditures were approximately X% of allowances, indicating a single multiplier mind-set; the analysis provided below shows that the variations in expenditure rate between DODICs, and between years for a single DODIC, prevent development of a representative expenditure rate.

The GAR Study Team analyzed Corps-level training munitions allowances and expenditure data for 369 different DODICs[31] for FY05, FY06, and FY07 provided by TECOM. Determining the average expenditures relative to allowances was complicated by three conditions. First, there were numerous (28 DODICs in FY05, 21 DODICs in FY06, and 35 DODICs in FY07) instances in which munitions with allowances had zero expenditures. Incidents of this for a single year do not indicate that the training allowances are necessarily calculated incorrectly, as it is possible that the pattern of unit deployments prevented expenditures of specific training munitions in a given year or replacement munitions were used. However, it is worth examining cases where this condition pertains across multiple years, examples of which are provided in Table 7-5 below.

Years	Number of DODICs with Allowances but Zero Expenditures	DODICs
FY05 and FY06	7	A415, D003, D539, M168, MU11, FZ14, FZ17
FY06 and FY07	12	MN14, B534, A415, D003, D539, M168, MU11, N205, N209, FZ14, FZ17, MM28
FY05 and FY07	13	A085, A246, PN16, FZ15, FZ16, A415, D003, D539, M168, MU11, B634, FZ14, FZ17
FY05, FY06 and FY07	7	A415, D003, D539, M168, MU11, FZ14, FZ17

Table 7-5: DODICs with Training Allowances but Zero Expenditures Over Multiple FYs

If unit deployments prevented training expenditures, it is reasonable to expect that this would not occur in two consecutive years. Thus, it is unclear why seven DODICs had allowances but no expenditures for each of the three fiscal years.

Second, munitions with no allowances but non-zero expenditures were also noted in the data. Four DODICs (BA06, BA13, K865, PD62) in FY05 and one DODIC in FY07 (AA68) fit into this category. Given the limited scale of the expenditures, and the fact that they did not occur in more than one of the three years for any specific DODIC, these likely represent unique training requirements for specific forces prior to mission deployment.

Third, three DODICs (AA49, A136, A171) had a negative expenditure rate listed for FY07. Thus, the analysis presented below, with the exception of the cost-related analysis which is

[31] TECOM provided the GAR Study Team with data for 379 DODICs. The 10 DODICs with zero allowances and zero expenditures for each of the three years are not represented in the analysis.

further constrained due to the availability of cost data, represents only the 237 DODICs which had expenditures and allowances in FYs 05, 06 and 07.

Simply summing allowances and expenditures for all DODICs yields an annual expenditure of 64%, 58%, and 55% of allowances for FY 05, 06, and 07, respectively. This methodology, frequently used in Marine Corps studies, over-emphasizes the importance of small arms which have a high expenditure rate and comprise a large percentage of the sum of all rounds, and under-emphasizes DODICs which have relatively small allowances and expenditure rates. The flaws of this 'one number fits all approach' are seen in the two examples below.

Grouping DODICs by average expenditure rate for each DODIC, as shown in Figure 7-1 below, indicates that an average of 36% of all DODICs have an expenditure rate of less than 20% of the allowance, and 61% have an expenditure rate of less than 40% of the allowance. Less than 5% of all DODICs have an expenditure rate greater than 80% of the allowance. This shows that the average expenditure rate calculated by summing all DODICs (calculated as 55-64% above) is actually skewed by a small proportion of munition types that have a relatively large number of rounds allowed and expended.

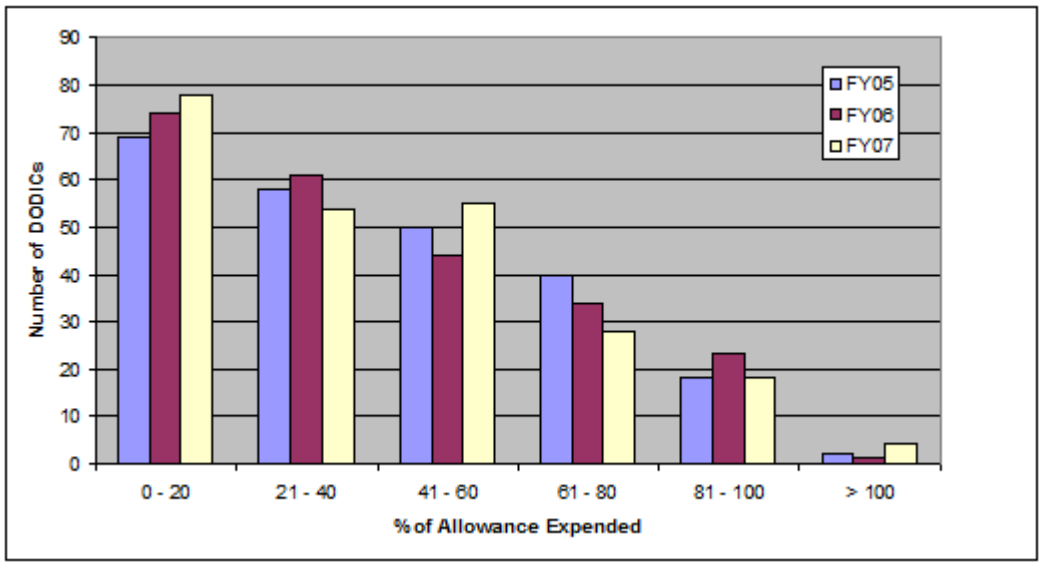

Figure 7-3: Expenditure Rate Relative to Allowance Across 237 DODICs, FY05-07

For any given DODIC, however, the expenditure rate fluctuates across the range bands from year to year, a fact not reflected in Figure 7-3 above. In fact, in 120 out of the 474 year-to-year by DODIC comparisons (FY05 to FY06, FY06 to FY07), the change in allowance expended was greater than 40%. Nearly 9% had a delta greater than 80%. This reinforces the point that averaging misses large variations in expenditures and is not an appropriate means for estimating or describing requirements.

The GAR Study Team performed exploratory analysis in an attempt to determine a relationship between expenditure rates and the cost per round of each type of DODIC. In the

event, however, dollar value estimates were not available for all types of munitions. Thus, the analysis presented below represents only the 202 DODICs for which non-zero allowances and expenditures were realized for each year and cost data was available. If such a relationship exists, it would be possible to determine the critical requirement based upon the dollar value of the munition. The graph below plots the maximum DODIC expenditure rate relative to allowance for FYs 05-07 against the cost of the munition. Statistical analysis revealed no clear relationship between these two variables.

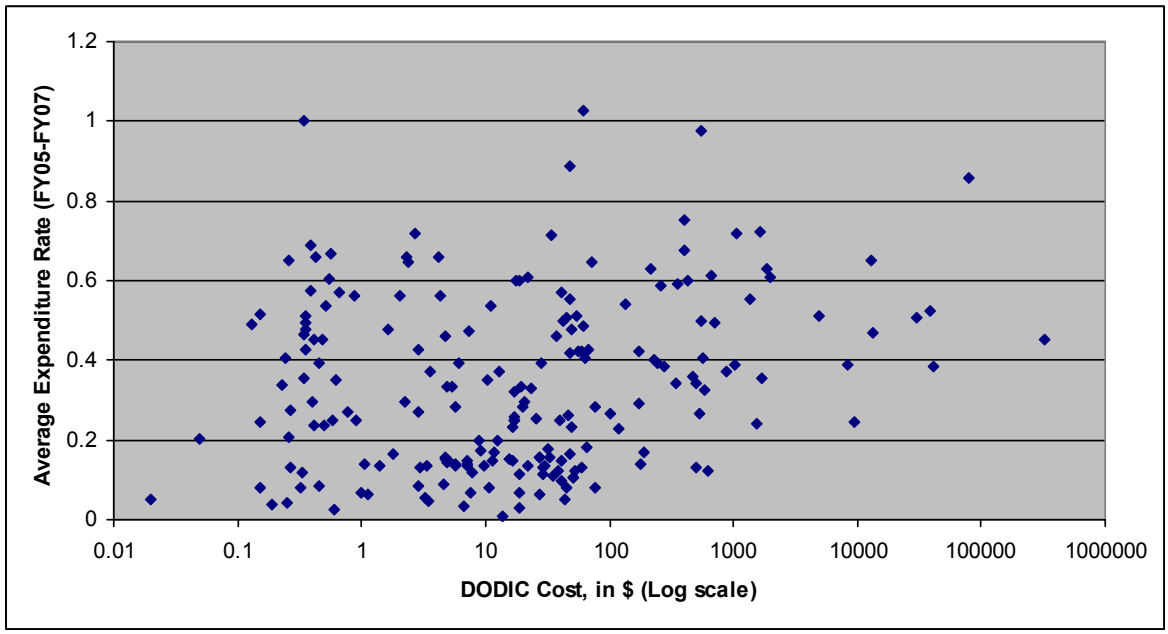

Figure 7-4: FY05-07 Training Expenditures/Allowances by Cost per Round

Finally, the GAR Study Team attempted to determine the "worst" DODICs as represented by the potential opportunity cost associated with purchasing decisions based on allowances that are not closely aligned with actual expenditure rates. This opportunity cost for each DODIC presented in Figure 7-5 below is calculated as the difference between allowance and expenditure multiplied by the cost per round of the munition. The five DODICs with the greatest lost opportunity cost are highlighted.

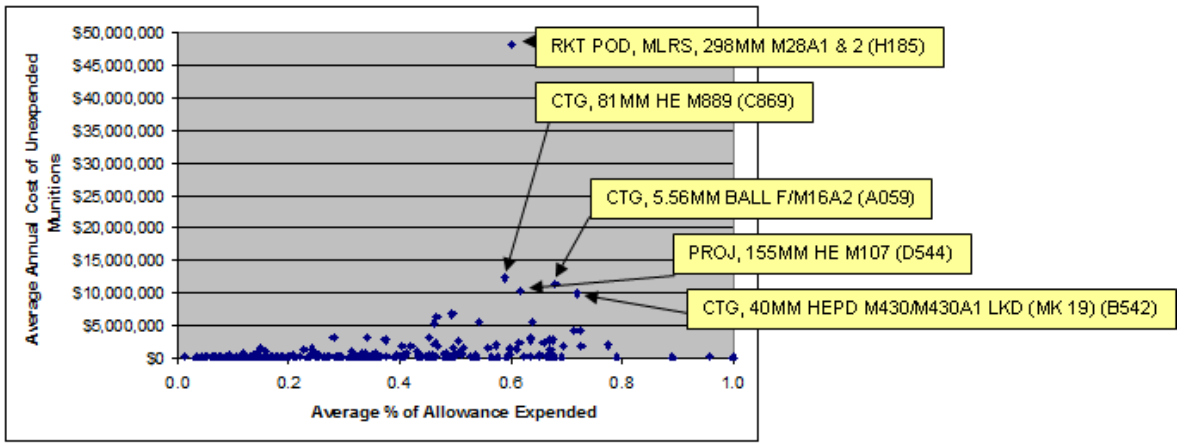

Figure 7-5: Comparison of Training Allowances to Expenditures (FY05-07)

This type of analysis is useful in identifying DODICs where additional focus is necessary to improve the accuracy of requirements and limiting the potential opportunity costs. For example, an examination of A059 shows some alarming trends. Between FY05 and FY06, the allowance was increased by nearly 89% while the expenditure rate increased by only 45%. Between FY06 and FY07, the allowance increased nearly 26% while the expenditure rate grew by less than 20%. In cost terms, the difference between allowance and expenditures for A059 grew from $3.4 million in FY05, to $12.9 million in FY06, and to $17.6 million in FY07. By identifying and exploring outliers in this manner, TECOM might be able to improve its allowance estimates.

This exploratory analysis confirms the judgment of the GAR Study Team that a critical, non-peacetime requirement should be developed using DODIC-specific values and not single-point or average statistics, and that additional analysis should be used to identify and address potential problems in the training munitions requirements estimates.

Link: 4.2.4.1 – Current Methodology for Computing Training Requirements (Page 64)

Link: 5.2.4.1 – Problems with and Commentary on Computing Training Requirements (Page 86)

7.2.4.2 Determine Title 10 Requirements

Given that TECOM is responsible for submitting the TTR, it is suggested that the MARFORs provide their estimates of Title 10 requirements to TECOM for review and incorporation into the TTR prior to TECOM's delivery of the TTR to MCCDC.

Link: 4.2.4.2 – Current Methodology for Determining Title 10 Requirements (Page 66)

Link: 5.2.4.2 – Problems with and Commentary on Determining Title 10 Requirements (Page 88)

7.2.4.3 Compute Peacetime Pipeline (PPL) Requirements

An argument can be made that the Approved Acquisition Objective, or AAO, which determines the levels to which MARCORSYSCOM can purchase munitions on an annual basis, requires a PPL to avoid future shortfalls in munitions. This can be shown with a simple example:

> Suppose that Unit A has a yearly training allowance for 10,000 widgets (a training-specific munition). Then suppose Unit A's deployment schedule in FY07 prevented it from expending any training munitions and therefore it begins FY08 with a full inventory of 10,000 widgets. In this case, with no difference between its current inventory and its yearly training requirement, no widgets will be ordered for this unit in FY08. Then suppose that during FY08, Unit A does not deploy at all and is therefore able to perform all of its required training, which means that at the start of FY09 the unit's inventory of widgets will be zero. The purpose of the PPL is to mitigate the impact of such fluctuations by anticipating expenditures ahead of actual inventory reductions from use.

This example is obviously an extreme case. Most units will have some training munitions left over or have some munitions ordered the previous year that are just showing up, but the example exposes the underlying problem the PPL is designed to address. This problem is amplified by the geographic distribution of units that prevents economically feasible sharing of munitions. It must also be remembered that the munitions previously ordered will not represent a "double counting" of the requirement as Marine Corps purchasing levels are determined by the requirement minus the inventory. Thus, any munitions ordered in previous years that are currently in the pipeline will not be purchased again.

The MCCDC ARO has requested that any revision of DoDI 3000.4 include a logistical pipeline for training-specific items. The logistical pipeline, it was suggested, "can be up to an additional year's requirement depending on production/delivery lead-times." (Barack, 2007) Version 6 of the proposed revision to DoDI 3000.4, however, continues to omit this requirement. The Marine Corps has, however, included the PPL as part of its TMR for over a decade without comment from DoD, establishing a precedent for its continued use.

As noted earlier in section 5.2.4.3, various documents and orders within the Marine Corps contradict one another with regard to the need for and composition of the PPL. The GAR Study Team is indifferent as to whether the Marine Corps decides to continue to define the PPL as a component of the TMR, unless otherwise directed by DoD, or defines it separately from the TMR but includes it in the definition of the AAO. Regardless, the PPL should be defined as a pipeline required to support training-unique munitions only.

What is important, however, is that a new order be issued, most appropriately through MARCORSYSCOM, which definitively identifies the reasons for including the PPL in the TMR or AAO and which defines the specific relationship between the PPL, AAO, and TMR, as well as the composition formula for the PPL. Owing to the broad disparity in costs and delivery schedules of munition types, it is further suggested that a more detailed

approach, and not the weighted-average used historically, be used to calculate the PPL.

The FY-10 PPL submitted with the POM-10 TMR includes 131 training-unique DODICS, representing over 80 million individual rounds with a value of just under $300 million. This represents more than 6% of the TMR total dollar value minus the PPL, an amount clearly warranting detailed analysis. MARCORSYSCOM, being most familiar with the manufacturing and logistical processes involved, should spearhead the effort to refine and document a clear PPL methodology that generates credible values by DODIC.

Finally, as with the Title 10 training munitions requirements, any new definitions or processes defined with regards to the PPL should be included in updates to MCO 8000.7, TECOMO 8011.1, and any other pertinent documents or orders.

Link: 4.2.4.3 – Current Methodology for Computing Peacetime Pipeline Requirements (Page 66)

Link: 5.2.4.3 – Problems with and Commentary on Computing Peacetime Pipeline Requirements (Page 88)

7.2.5 Determine Testing Requirement

No issues, concerns or problems were noted with the current Marine Corps process of determining the testing requirement, thus no modifications to this process are currently required.

Link: 4.2.5 – Current Methodology for Determining Testing Requirements (Page 66)

Link: 5.2.5 – Problems with and Commentary on Determining Testing Requirements (Page 45)

7.3 Phase III – Validation, Approval, and Submission of the TMR

The validation process performed for POM-10 was more thorough than ever before. However, to preserve the gain, the process must be documented and codified into any updated version of MCO 8000.7. This validation process should involve an initial analytical review of the data followed by a two-step validation process similar to that used during the POM-10 MRP.

Upon receipt of the initial TMR from the organization perfoming the WRMR model runs, a USMC analytical agency such as the MCCDC Operational Analysis Division should be tasked with performing a detailed assessment of the results. This assessment should, at a minimum: look for output anomalies that indicate an input data or process error; evaluate the TMR by component; and perform a comparison of historical results by DODIC. The breakdown of the TMR by component would include an analysis of expenditures by CR, CO/FPR, SRR, and TTR, with the combat requirement further sub-divided into target-oriented and specific non-target-oriented expenditure categories.

Should time or resource constraints prevent analysis of every DODIC, the assessment should focus on three important areas: DODICs with the highest priority as defined by MARCORSYSCOM; DODICs representing the greatest cost expenditure; and DODICs that have had a significant increase or decrease in expenditures as compared with the previous year's TMR.

Any problems or issues identified by the analysts should be corrected, and a new draft TMR generated. The new draft TMR will again be analyzed, and this cyclical process will continue until analysis can identify no outstanding issues.

Once the analysis is complete, the draft TMR should be distributed to members of the MRP AWG by way of an MCATS tasker for review and comment. After adjudicating any issues identified by the MRP AWG, the draft TMR should then be presented to a senior-level oversight committee, such as the CDIB. This presentation should include key assumptions and data elements used to develop each portion of the TMR, the cost breakdown of the TMR, as well as a historical analysis to place the current TMR in perspective and note identify any significant fluctuations in requirements for specific DODICs.

If additional problems or issues are identified by the senior-level oversight committee, these problems should be addressed and a new draft TMR developed. If the issues are minor or affect a limited number of DODICs, the senior-level oversight committee should be asked to approve the new values after a cursory review. In contrast, major changes to the draft TMR should dictate a new presentation noting all of the changes and their impact on the final TMR for formal review and approval.

Upon validation of the draft TMR by the senior-level oversight committee, the final TMR along with the supporting presentation and the validation of the committee should be briefed to the Commander of MCCDC for approval. Once approved, this final TMR is submitted to DoD.

Link: 4.3 – Current Methodology for Validation, Approval, and Submission of the TMR (Page 67)

Link: 5.3 – Problems with and Commentary on Validation, Approval, and Submission of the TMR (Page 90)

8 WRMR Model-Generated Combat Planning Factors

Combat Planning Factors (CPFs) generated by the WRMR model are currently used for two purposes. First, they define the munitions expenditure rates for assault and sustained operations and they are used within the MRP to calculate the expenditures associated with the CO/FPR and SRR. Second, they are used by operational planners and ammunition officers in the field to determine munition requirements for their units in preparation for operational deployments. This section explores these uses of CPFs and notes their validity for each application.

8.1 Validity of the CPFs

The CPFs generated by the WRMR model are mathematical representations required to develop the CO/FPR and SRR components of the TMR. The CPFs generated must be compared to historical real world operations in order to establish the validity of this representation since they are also being used in the field by operational planners and ammunition officers.

A numerical analysis of expenditures during major combat operations in OIF would be the standard approach to assess the validity of the WRMR model-generated CPFs against a real-world benchmark. The GAR Study Team was unable to perform this type of analysis owing to a lack of data. While MARCORSYSCOM was able to provide total rounds of ammunition expended by type for OIF, the GAR Study Team was unable to locate a source for USMC weapon density data for OIF. Although it would seem possible to determine approximate weapon densities by evaluating unit deployments, this is also not feasible given the unique situation in Iraq where Marine Corps and Army units are deployed without their standard TO&E given that their opponents are an insurgent force and not a standing army. Absent information on the number of weapons by type in theater, it is not possible to determine a daily expenditure rate.

In addition, during interviews, II MEF ammunition officers voiced concerns about the accuracy of the ammunition expenditure data compiled in the field. Each unit is supposed to report daily detailed expenditures in a Munitions Report (MUREP) and forward this information up the chain of command to be compiled and summarized with submissions from other subordinate units. This does not happen for a number of reasons. First, all units are not able to consistently submit their expenditures on a daily basis as they may not have the means to report during an operation. This leads to a "rolling up" of expenditures at the end of a given operation. In addition, while the Marine Corps ma*intains a standard reporting format, the current version lends itself to errors at the unit and command levels. Finally, lack of automated software capable of integrating subordinate reports into a single expenditure report also introduces opportunities for accounting errors.[32,33]

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[32] An automated software package to compile munition expenditure data is available at the Joint level; however, ammunition officers interviewed indicated that they were never provided the training necessary to use it. The Marine Corps is currently developing an automated system that works via the Commodity Reporting System and will reside on the

Lacking the ability to perform numerical analysis that would benchmark the WRMR model-generated CPFs against real-world operations, the GAR Study Team relied on the opinions of experienced ammunition officers, warrant officers and NCOs currently supporting II MEF, including representatives from G-4 Plans, the 2nd MLG, and the II MEF Ammunition Officer. The consensus opinion was that, while unique unit SOPs, munitions and logistical constraints, and specialized mission requirements usually resulted in an ammunition requirement that may be different than the WRMR-derived CPFs, the WRMR-derived CPFs were generally valid and useful as a starting point during initial planning for combat operations. For smaller sized units, specialized missions would often lead to requirements that were significantly different than the published CPFs but these differences did not substantively change the expenditure rates at higher levels, such as the regiment, division, and MEF.

This consensus, however, is suspect as the ammunition officers, operational planners, and combat service support school representatives interviewed identified two additional sources for CPFs used when determining munitions requirements for specified, real-world operations. These sources are:

- MCO 8010.1E, entitled *Class V(W) Planning Factors for Fleet Marine Force Combat Operations*. This document defines the CPFs for both direct- and indirect-fire weapon systems to be used during initial planning for combat operations. Dated 15 April 1997, this document was generated during the Marine Corps Class V(W) WMR Study of 1995-1996. This study used MCARMS to model two major regional contingencies (MRC) derived from the then-named DPG Illustrative Planning Scenarios. Separate CPFs were generated for infantry-heavy and armor-heavy threat environments, as well as a composite CPF, which was an average of the CPFs of the two scenarios weighted by the densities of the weapons and the durations of the scenarios. Each DODIC in the infantry-heavy, armor-heavy, and composite tables has a daily assault rate representing a high-intensity combat environment, and a daily sustained rate, representing a lower-intensity combat environment. Assault and sustained rates are also provided to account for the weapon being in a GCE or non-GCE unit (if applicable). In addition, each DODIC is assigned a basic allowance (or combat load), which is further conditioned by GCE/non-GCE status. Marine logistics and ammunition schools teach students to use this order to obtain CPF data.

- The *MAGTF Planners Reference Manual* published by the MAGTF Staff Training Program Center. This booklet contains daily expenditure rate data for indirect-fire weapons systems. Tables 4-9, 4-11, and 4-13 in this manual provide

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Global Command and Control System (GCSS), but no anticipated fielding date has yet been identified.

[33] On 19 May 2008, MARCORSYSCOM indicated that problems associated with the MUREPs have been corrected and that "the current MUREP format captures the training expenditures associated with the Marines in a combat zone, whereas the older version did not. The data is fed to the Joint Staff via an automated MUREP and the reporting of expenditures is now both timely and accurate." (Howell, 2008)

> expenditures per day for infantry-heavy, armor-heavy, and composite threats, respectively, based on an 18-gun M198 battalion. These tables are sub-divded by offense and defense, with offense numbers including a "basic allowance", or combat load. For direct-fire weapon systems, section 4026, paragraph g of this manual informs the reader to obtain this information from MCO 8010.1E and notes that this order "requires updating to incorporate OIF/OEF experience."

In comparing these source documents, it is important to note that MCO 8010.1E defines planning factors for infantry-heavy, armor-heavy, and composite threat forces. The WRMR model, however, only produces the composite threat CPFs as is the standard now used by the USMC. In addition, comparing the composite MCO 8010.1E CPFs and those generated by the WRMR model in support of the POM-10 TMR shows dramatic differences. From a possible total of 433 weapon/round combinations, only 22% were found in both sources. Further, 54% of the total combinations is not in the MCO 8010.1E, having been introduced after its publication. Of the common combinations, for both GCE and non-GCE rates the value of every CPF were different, with approximately 80% having a difference of greater than 40%.

Differences of this degree should be expected. These CPFs were generated over a decade apart using different models, scenarios, and other input assumptions. Even comparisons between the WRMR model-generated CPFs developed to support the POM-10 and the Program Review (PR) for FY09[34] process show significant differences. Of the 350 possible weapon/round combinations, only 85% were common, the others being retired or newly introduced. Almost 80% of the assault and sustained rates were different, with more than 50% of the deltas being greater than 40%.

Again, these changes can be explained. Between the PR-09 and POM-10, several changes to the WRMR model were made based on the findings of the WRMR Model V&V Study Team. In addition, new TRs and PTDs and other data would lead to different CPFs.

The GAR Study Team identified two possible solutions to ensure the validity of CPFs in the future. In the short-term, absent the ability to validate the WRMR model-generated CPFs from historical benchmarks, the field consensus appears to be the only option. This consensus will be more credible if the USMC defines a standard set of CPFs which is utilized by all operational planners and ammunition officers throughout the Marine Corps for a period of time. Following real-world use, MCCDC should again obtain the professional opinion of these operational planners and ammunition officers to validate the model-generated CPFs. A numerical analysis, however, would be more objective and provide an analytical underpinning to CPF validity. This analysis would be possible if the Marine Corps tracked weapons involved in combat operations that experienced weapons expenditures, possibly incorporating this data into the MUREP already generated by

[34] PR-09 was an off-cycle update to the POM-08 TMR. PRs are only performed if changes to inventory levels, weapon development or implementation, modeling, or other input data or assumptions will result in a sizeable change in the munitions requirements from the previous POM cycle.

deployed units.

8.2 Urban/Counter-Insurgency Operations CPFs

The validity of WRMR model-generated CPFs would also benefit from a representation of a broader range of operations than is currently available. As American military operations in Iraq and Afghanistan have made clear, urban/counter-insurgency operations present a set of requirements vastly different than those experienced during high- or low-intensity combat operations against an opposing nation's regular armed forces. CPFs need to be developed to support the planning of these operations. GAR Study Team interviews with Marine Corps ground ammunition officers reaffirmed this conclusion.

Simply increasing or decreasing the assault or sustained rates in the WRMR model-generated composite CPF, which portrays major combat operations, is not a valid approach since military operations on urban terrain (MOUT) and counter-insurgency operations employ a completely different mix of weapons and engagement times. The aforementioned Field Artillery Journal article by Major Field supports this. In the lessons learned section of the article, he notes:

> *Artillery Ammunition Apportionment in an Urban Fight.* RCT-2's battle in An Nasiriyah was, for the most part, an MOUT fight. Before departing Camp Shoup on 20 March, the initial issue of artillery ammunition was based on a combat planning factor of a composite enemy threat (armor and infantry) and included a much greater mix of "long shooters" than HE munitions—RAP and base bleed DPICM (BBDPICM).
>
> Would a different mix of ammunition have been requested if an urban fight were anticipated? Yes, but based on what planning factor? The primary source for ammunition planning, Marine Corps Order (MCO) 8010.1E Class V(W) Planning Factors for Fleet Marine Force Combat Operations, depicts ammunition allocations based on enemy composition (armor- or infantry-specific or a composite of each) rather than terrain, such as the urban environment of An Nasiriyah. CPFs for these types of operations couldn't be represented by a simple multiplier on either the assault or sustained CPFs, but could have to be represented by a completely new set of CPFs to account for the differences in weapon employment in these types of operations as opposed to normal combat operations.

The GAR Study Team proposes the development of a new CPF that would support these operations. Correctly identifying a methodology to perform this calculation is not trivial and should be evaluated at length. The GAR Study Team proposes two possible approaches.

The first approach involves expanding the scenarios to include a phase of urban/counter-insurgency operations within the WRMR model. The COCOMs produce the required data as part of their PTD process. An initial examination of the target set associated with urban/counter-insurgency operations should be performed to assure that the opposing forces

are primarily composed of enemy infantry, mortars, and other small-arms or light weapons indicative of these types of actions.

The urban/counter-insurgency CPF would be calculated as an average of the daily expenditures over the duration of the phase, which is consistent with the current WRMR model methodology. One change that would be required in the model is to account for the removal of Marine Corps forces that are redeploying out of theater. This change is important to account for fluctuations in the weapons mix. The WRMR model could be modified to incorporate the removal of assets by time and quantity. Alternatively, a way to account for the change would be to conduct two separate model runs, one for major combat operations, and one for urban/counter-insurgency operations.

A second approach to creating an urban/counter-insurgency CPF is to employ a methodology similar to that proposed earlier for rear-area expenditures in section 7.2.1.3. In this manner, daily expenditures for urban/counter-insurgency operations would be calculated by DODIC for both GCE and non-GCE forces as follows:

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Urban/Counter-insurgency Operations Daily Expenditures = (# of incidents/day) *
(rounds/incident)
```

This methodology has a number of advantages. Its level of fidelity is similar to that used to calculate non-target-oriented munitions expenditures. Additionally, the data necessary to perform this calculation should be readily available via historical OIF and OEF reports. Finally, this methodology would not require changes in the way threat reports, PTDs, and similar DoD- or COCOM-developed data are currently produced.

8.3 Improving the Utility of WRMR Model-Generated CPFs

The GAR Study Team identified three additional problems associated with the generation and dissemination of the CPFs.

First, comparative analysis of WRMR model-generated CPFs with those generated in the previous MRP cycle is currently performed after TMR submission. This analysis should be performed during the analytical review of the draft TMR in order to identify changes in CPFs and confirm that the changes are not due to data or methodological errors. Ideally, all munitions should be evaluated for discrepancies but, at a minimum, this review should include: the priority munitions as determined by the MEFs, MARFORs, and TECOM; munitions representing the greatest dollar value; and munitions having a significant delta from the previous MRP cycle.

Second, MCCDC currently uses an informal “push” system, i.e., e-mails from the ARO to the MARFOR and MEF ammunition officers, to distribute updated WRMR model-generated CPFs. A formalized approach to distribution would help ensure all ammunition officers and operational planners throughout the Marine Corps have access to the most current CPFs. A draft update of MCO 8000.7 currently under review proposes the establishment of a web site, which could be accessed by Marine Corps personnel to obtain this data. Alternatively, MCCDC could publish an updated MCO 8010.1E biennially in conjunction with the

submission of the TMR.

Third, the combat service support schools continue to teach that MCO 8010.1E CPFs should be used by operational planners. Instructors from this school interviewed by the GAR Study Team stated that they were aware the updated WRMR model-generated CPFs had been distributed via e-mail, but they had not received these CPFs and no Marine Corps order indicated that these were authoritative. If the Marine Corps decides the WRMR model-generated CPFs are to be the standard for operational planners, then the school should be notified of this and be provided appropriate guidance on how to access them.

9 Envisioning a Future USMC MRP

The previous eight sections of this report provided a detailed critique of the current MRP, identifying issues, problems, and concerns, and providing potential solutions to each of these problems. These eight sections satisfy all of the requirements associated with the study, and responses to all key study questions can be found within these sections.

The purpose of section 9 is to provide newly assigned AROs a view of the Marine Corps MRP from three separate yet related perspectives. The first view looks at the MRP from an **analytical perspective** to identify *what* needs to be done such that the MRP can proceed from a clear objective, common practices and transparent methods to produce credible, defensible estimates regardless of changes in the DoD guidance or models used. The second view shows the MRP from an **organizational perspective** to identify *who* across a range of activities and functions should perform the specific roles and responsibilities that when combined will produce a coherent, comprehensive process. The third view reflects an **execution perspective** of the MRP, as in *when* and *how* things are to be done such that contributions and activities are aligned with milestones that support a synchronized schedule of products and results.

9.1 The MRP from an Analytical Perspective

The MRP is a complex undertaking.[35] First, it occurs over an extended timeframe, meaning change in nearly every aspect, be it source data, methodologies, tools or participants, is to be expected. Second, it involves multiple players, with geographical and organizational distances making communications difficult. Finally, it involves nested processes wherein any problems and misunderstandings are compounded as they pass between supporting and supported activities and eventually cascade through the results.

The complexity of the effort then lends itself to the ordered treatment associated with a formal analytical study. Over the past few decades, military analysis has both adopted and created approaches that bring a high level of scientific rigor to quantitative assessments in support of policy, operations and acquisition issues. MCCDC itself has incorporated this level of discipline in its establishment and management of the Marine Corps Study System (MCSS).

The order associated with formal analytical studies in general and with the approach to them within the MCSS construct in particular would offer a number of benefits if applied to the conduct of the MRP. These include:

- Formal taskings in terms of data calls and reviews having more authority across the range of participating organizations;

[35] Much of the discussion in this section is amplified in the Deployed Analyst Handbook developed by CAA. This is a valuable reference document that the GAR Study Team recommends as a resource for all incoming AROs.

- responses to data calls and requests being informed by the study objectives and templated to promote uniformity in format; and

- documenting the process as a study design to promote repeatability across cycles and to support trends analysis to provide in-depth answers leadership inquiries.

The GAR Study Team proposes that the Marine Corps avail itself of these benefits and adopt a formal study approach to the conduct of the MRP. If executed in this manner, the MRP would have the following elements:

- an Organizational Framework that establishes and publishes clear lines of authority and responsibility for actions and products associated with the MRP. This would go beyond first-order assignments to put an appropriate organization, skill set and/or position against a given role. A proposed Organizational Framework is discussed in detail in section 9.2 below.

- an Analytical Framework that establishes the objectives of the effort, details the approach to realizing them, describes the major tasks to be undertaken and clearly identifies all the essential elements of analysis (EEA). A proposed Analytical Framework is discussed in detail in section 9.1.1 below.

- a Communications Framework that embodies an effective and efficient channel for sharing information and organizes the information for accurate access and reporting. A proposed Communcations Framework that embodies a dedicated web site and archiving architecture for the MRP is discussed in detail in section 9.1.2 below.

9.1.1 Analytical Framework for the MRP

Estimating ammunition requirements is a dynamic problem. From cycle to cycle there will be changes in planning variables such as the size and shape of the force and the nature and scope of the operations that force is expected to support. There will also be changes over time in the assumptions, tools and methodologies applied to calculate expected system use rates and ammunition expenditures for forces conducting those operations. This report documents the recent changes in the guidance and data sources that inform the derivation of ammunition estimates and these will certainly continue to evolve. Combined with the near-constant rotation of participants across the numerous offices and organizations involved in the MRP, the pace and scale of change points to the need for an enduring analytical approach to impose order and promote consistent results to the USMC leadership.

The first element of an enduring approach should be an analytical framework to serve as a guide to the eventual implementation and execution of the MRP. The framework will ensure the basic set of information necessary to get at the problem – the essential elements of the analysis – is defined and captured. Additionally, the framework will help participants across the range of organizations involved produce consistent estimates, coherent explanations of underlying assumptions and accurate illuminations of the differences in

results over time. The analytical framework provided below reflects a three-step process flow – collect data, perform analysis, validate results – that is standard for any quantitative assessment. Further, it aligns with the approach used by the Joint Staff for simulation-supported analyses and is typical of approaches used by MCCDC OAD's peer organizations across the Service staffs. The Joint Staff approach involves three categories of action:

- Data acquisition, analysis, preparation, and management;
- Model execution, output review, and processing; and
- Analysis and product support.

9.1.1.1 Collect Data

The USMC MRP must account for five core elements necessary to produce informed estimates of munitions requirements:

- the size, shape and structure of the forces involved;
- the type, nature and number of the operations to be supported;
- the conditions under which these forces will conduct these operations (pace, intensity, type, nature and number of threat targets, threat repair/reconstitution rates, etc.);
- the allocation of munitions to uses categorized by domains and functional areas (air or ground, combat or non-combat, target-oriented or non-target-oriented, etc.); and
- the allocation of munitions to other categories (combat loss, wastage, pipeline, allied exercise support, training, testing, etc.)

Capturing and understanding these elements will be an essential part of any MRP, no matter how the guiding documentation or the tools evolve.

Obtaining this data will require a collaborative effort between the ARO and various Marine Corps and DoD organizations, and will be most efficiently and effectively conducted via a standardized collection and updating process. Publication of an overview of the MRP as an analytical effort – essentially a study design brief that describes the objectives of the MRP in both a DoD and USMC context, breaks out the components of the TMR and their relationships, and explains the means (tools and methodologies) by which the estimates will be produced – will be useful in ensuring that all participants share a common understanding of a collective process. To support specific data calls, it would be also helpful to develop questionnaires that include appropriate context for responders to understand the purpose of the requested information and provide formats that allow responders to see exactly how the information will be used and what assumptions underlie that usage. The MCATS system can be used to distribute the requests to appropriate agents and track their disposition.

In this step, the ARO and/or his support personnel should establish a plan for acquiring data consistent with the study parameters, execute the necessary data calls and coordinate their distribution through MCATS. They should be prepared to interact directly with authoritative data providers to ensure that the information is compatible with the resolution and scope of

the tools and methodologies to be used for the analysis.

The acquired data should be evaluated for comprehensiveness in terms of the requirements of the study and the inputs required for the selected models. This will typically require reviewers to have extensive knowledge of U.S. and foreign force structure, regional and theater-specific characteristics, and asymmetrical operations as well as the internal structure and input requirements of the supporting model to identify data gaps, deficiencies, and errors. The reviewers should exhaustively work through the various model input files to compare required values and allowed value ranges against the acquired data. They should routinely document the state of the data, report it to the Study Lead and pursue new data to resolve any problems.

Preparation of the data requires converting or re-formatting the acquired data as necessary to conform to model-specific input requirements. To promote accuracy and efficiencies to meet demanding timeframes, personnel should be sufficiently skilled in computer science techniques to employ software routines, spreadsheets, and other tools to convert raw data into properly formatted, model-ready inputs.

Data management and maintenance is typically undertaken by developing clear "pedigree" documentation for all model input values, producing appropriate descriptive metadata establishing the context for their use, clearly identifying the source for the data and explaining any means by which it was converted or modified to meet model-specific formats. Surrogates must be identified so that it is understood by follow-on MRP personnel the data is not "pedigreed" and should be updated as more complete data becomes available. Any subjective data used to support the analytical tool should also be noted, including the assumptions that were used to develop the data. Finally, the data files must be properly named, configured for archiving and stored for responsive retrieval to support use in future actions as well as to permit timely upkeep and maintenance activities associated with data changes and backwards compatibility to accommodate new model version releases.

9.1.1.2 Perform Analysis

A variety of analytical tools can be used to help develop the TMR. This is clear from examining the models currently used by each of the Services. For example: the Marine Corps uses an assignment program, i.e., its WRMR model; the Army employs a campaign-level model; the Air Force uses an optimization program; and the Navy uses a collection of models that combine a variety of techniques to determine munitions requirements.

It is standard DoD-wide policy that an analytical tool should be verified, validated, and accredited for the specific task to which it is being applied. Verification is "the process of determining that a model or simulation implementation accurately represents the developer's conceptual description and specifications." Validation is "the process of determining the degree to which a model or simulation is an accurate representation of the real world from the perspective of the intended use." Accreditation is "an official determination that a model or simulation is acceptable to use for a specific purpose." (Secretary of the Navy, 1999) Whenever modifications are made to the analytical tool, the VV&A process must again be

performed to ensure that the modifications are implemented correctly, that they continue to accurately represent real world activities, and that the model remains valid for use in determining the munitions requirement.

Accreditation is essentially a "blessing" that occurs prior to the use of the model for an application. Verification and validation, on the other hand, are on-going activities that should occur in-line with the model's operation. These must be accounted for in this step. First, the ARO and/or his support personnel must ensure that the computer environment associated with the model is configured to accommodate the run matrix necessary for the study and that runtimes will be responsive to the study schedule. Model output results must also be rigorously analyzed to verify completeness and accuracy. Stabilization runs of the model support this activity. Model "crashes" provide notice of certain types of problems such as incorrect input formats. Other issues require detailed review of results, possibily through sensitivity analysis to isolate and explain areas of interest and/or comparison against historical expenditures in similar scenarios, to establish that input values are correct and appropriate. The initial results of model runs should be evaluated against a broad range of metrics to ensure representations are valid. Scripts can be adjusted or created to capture any additional metrics if necessary. The run matrix should be compared against the study design to ensure the complete range of scenarios is covered. Anomalies should be investigated and scenarios should be re-run if necessary to address errors and inconsistencies. When the model is stabilized across the scenarios, appropriate output pre- and post-processors must be used or created to capture the essential elements of the analysis and produce the initial filtering of results to support the development of final results.

9.1.1.3 Validate Results

After the final TMR has been calculated, the results must be presented to senior-leadership in a manner that supports thorough validation and approval. In order for the senior leaders to make an informed decision, the MRP presentation should contain more than just the final numbers. In the past, TMR presentations were known to feature unproductive exchanges between decision-makers asking about specific estimates only to have a briefer reply, "Well, sir, all I know is that the model says it's 278,850," a response that, needless to say, did not suffice. Senior leaders require a presentation that describes the constraints, limitations, and assumptions that affected the results. The presentation should also include a description of the models used as well as the scenarios and other input data used to populate the model. It is important to understand that extensive and specific data values are not necessary, but an overview of the data should be presented so that the senior leaders can verify that the requirement is representative of a valid and reasonable set of possible future combat scenarios.

In addition to the input assumptions and data, the presentation should provide an analysis of the results so that the senior leaders can understand the reasons for any significant changes between previous results. This analysis should also break out the requirements by each element of the TMR, providing the senior leaders with an understanding of how each element relates to the total requirement. Finally, the presentation should explain how the munitions requirement relates to the other acquisition objectives in the entire POM process.

In this step, the ARO and/or his support personnel should apply appropriate operations research techniques and analytical methodologies to interpret the results and develop first-order insights into the study objectives. Working from explicit knowledge of model input-output relationships, they can evaluate the on-hand results to determine boundary conditions for testing sensitivities and quickly prepare and run additional excursions to expand the utility of the analysis.

To support presentation of the results, model output data can be imported into spreadsheets to produce specialized graphics to facilitate analysis and enable insights. The ARO and/or his support personnel should be sufficiently skilled in Microsoft Office applications to compile this information across the baseline and any excursions as well across current and past MRP cycles. The presentations should reflect complex analytical conclusions in a variety of formats tailored to a range of audiences, i.e., from Action Officer to FO/GO.

9.1.2 Communications Framework for the MRP

The MRP is a fluid process, constantly being redefined, revised, and updated by the DoD as well as each of the Services.[36] Complicating matters further, the Marine Corps personnel associated with the MRP transition frequently, yet the munitions requirements defined in this turbulent environment are important elements in Marine Corps efforts to secure sufficient funding for its operations. Marine Corps requirements that are based on a transparent process, with traceable inputs, will result in sound analysis and improve the probabilities that the requirements will be funded. All of these factors emphasize the importance in maintaining a detailed, structured, and readily accessible database consisting of all components used to generate the TMR.

The MRP will always be a collaborative process requiring inputs from a diverse set of DoD and Marine Corps organizations. It is, therefore, advisable, that the documents and data be stored and maintained in an archive on a networked system that is accessible by all relevant organizations. The GAR Study Team developed a prototype MC MRP website to support the ARO in evaluating the utility of such an archiving system. Screenshots of this site are provided for illustrative purposes below; a functional HTML version of the website accompanies this report on a separate electronic medium.

[36] Many of the ideas presented in this section were derived from OPNAV N-81's Quickplace web site designed to maintain all documents and data used for the Navy's NNOR process. N-81's process is very applicable to the Marine Corps as the data requirements for the Navy's requirements model are similar to the Marine Corps' WRMR model, and because the Navy and Marines maintain similar unclassified and classified computer software architectures.

Figure 9-1: Illustrative example of USMC Munitions Requirements Process Database

Instantiation of such a web site in compliance with the NMCI architecture and population of its archive with data, while certainly feasible, will be a difficult and time-consuming process that is not likely to be fully accomplished within the tenure of a single MCCDC ARO. As with most such projects, the likelihood of success diminishes in direct proportion to the number of people responsible for making it happen. This reinforces the GAR Study Team's belief that, similar to the Navy, the Marine Corps needs to develop a civilian position in support of the ARO to support the long-term needs of the MRP.

Since a portion of the data is classified up to the SECRET/NF level, maintaining the database on a SIPR web site would likely be the best location for this database. (NOTE: It is strongly suggested that a mirror database not be developed on an unclassified web site. Although much of the data and documents are unclassified, maintaining two web sites, ensuring that duplicate documents are stored on each, and preventing accidental seepage of classified information onto the unclassified site strongly outweigh any potential advantages of maintaining a complementary unclassified site.)

The archive should contain all of the data required to support the five core elements defined in section 9.1.1.1 which currently includes DIA threat reports, COCOM-developed near-year PTDs and J-8-developed out-year PTDs, and JMEM data. Additionally, it should

contain the following: any model-unique data; DoD and USMC instructions, orders, and guidance; communications, such as e-mail, that describe process changes, assumptions, or data changes that impact the MRP; the model executables used to generate the TMR; the databases used with the given models; and historical results and analysis.

DoD and USMC instructions and guidance would contain all current and proposed documents that influence the MRP, such as the operative DoDI 3000.4 and the successor 8000.7. Proposed changes to documents should be maintained separate from the current documents, and e-mail and other correspondence between organizations and MCCDC regarding these proposed revisions should be maintained here as well.

Threat reports, including the documents providing target quantities by target type with narratives and the Excel spreadsheets detailing the fixed facilities should be stored here. This area should be sub-divided by POM year as well as near- and out-year.

Phased-threat distributions and any accompanying briefings or documents describing the assumptions, methodologies, or TPFDDs used to generate the PTD should be stored here. As with the threat report, this area should be sub-divided by POM year as well as near- and out-year.

WRMR model data should be separated and saved into data files. For instance, one file would be used to save JMEM lethality data, another for weapon-to-target allocation data, and so on. A file should also be created to maintain the heavily subjective data such as that found in the *param.in* file. Much of this data is currently stored in Excel data files. This is a preferable format because Excel supports Visual Basic for Applications and could be used to automate the development of WRMR input data files, reducing the likelihood data will be erroneously transposed into the model.

Each file should be assigned to a Marine Corps organization which maintains expertise in the given functional area. This organization should be tasked to review, update, and validate all of the data in the file. Any changes to the data, including date of change, organization responsible, assumption, and e-mail or other correspondence that resulted in the change should be maintained for traceability.

All final model executables and model documentation should be stored, allowing for recreation of specific TMRs. Changes to the model should be documented and accompanied by documents developed during V&V of the incorporated changes.

TMRs should be stored, also maintained by POM year (and PR year, if necessary) as well as near-year, out-year, constrained, and unconstrained. The TMRs should include any pertinent documentation or briefings detailing the assumptions, methodologies, or issues associated with the development of these numbers. This should include documents provided by TECOM explaining the process and assumptions used to develop the training requirement, documentation detailing Title 10 requirements, etc.

Finally, analysis should be performed on each TMR to ensure accuracy and to obtain a

thorough understanding of the composition of the TMR. This should include trends analysis and comparisons between the most recent TMR and those of previous years, with explanations provided for any DODIC which experiences a significant increase or decrease in a given year. Comparative analysis could also be performed to evaluate the TMR against munitions inventories and historical expenditures. This type of analysis would reduce the probability that mistakes or errors in the requirements process create unreasonable requirements for specific DODICs, and would increase the understanding of the requirements allowing for better acquisition decisions.

9.2 The MRP from an Organizational Perspective

When executed along the lines of a formal study, the MRP will have an Organizational Framework that establishes and publishes clear lines of authority and responsibility for its actions and products. This section will identify likely candidates to perform the tasks defined in the analytical perspective presented above.

For purposes of supervision and control, a study needs a study sponsor and a study advisory committee (SAC). These positions not only define the scope and requirements of the study but are key elements in the validation and approval tasks. The Director, Capabilities Development Directorate, approves the TMR for submission to DoD and would, therefore, be considered the study sponsor. As indicated in section 6.4.1, the Capabilities Development and Integration Board (CDIB) provides a standing body consisting of relevant organizations represented by officers of ranked at lieutenant colonel and above (or their civilian counterparts) that is already integrated into the POM process. As this group is already integrated into the POM process, it is reasonable to consider it to function as the SAC for the MRP study.

The ARO within the Logistics Integration Division is currently assigned to develop the TMR, making this position the obvious choice for the study lead. As discussed in section 6.4.3, the GAR Study Team strongly believes a corresponding or supporting civilian position should be developed. Periodic reassignment of officers to the ARO position impedes the development and application of a consistent methodology for performing the MRP. This civilian position would provide continuity and institutional memory to the process, allowing for a consistent approach to be developed over time.

As part of the MRP, the ARO is required to review materials developed by DoD, the Joint Staff, and the COCOMs pertaining the MRP, identify and integrate a broad array of data to support the model used, and resolve a number of issues that arise due to vague, contradictory, or non-existent guidance. To support the ARO in these tasks, an MRP Ammunition Working Group (AWG) should be developed, comprising organizations with functional area expertise and represented by staff- and action-level officers (or their civilian counterparts). The following organizations should be considered for membership in the MRP AWG based on their contributions to data development, understanding of operational plans, or involvement in the procurement process:

- MCCDC (as the chairperson)

  - TECOM
  - CDD
    - LID (as the AO level chairperson)
    - Total Force Structure Division (TFSD)
  - Operations Analysis Division (OAD)
  - G-3/5

- PP&O
- MARCORSYSCOM
- MC Aviation
- Installations & Logistics (I&L)
- Programs & Resources (P&R)
- MCIA
- MARFORs (supporting MCOs defined by Implementation Guidance)

In Table 9-1 below, the GAR Study Team has attempted to identify the organizations that have the functional area expertise to provide insight and develop accurate data to support the WRMR model. Where the GAR Study Team could not identify an appropriate organization, the MRP AWG has been inserted. The MRP AWG should be used to identify the organizations best suited to support each of the functional areas listed.

The input data in Table 9-1 below is the responsibility of the identified organization. Due dates in accordance with the execution framework described below in section 9.3 will be identified in the MCATS tasker.

WRMR Model Input Data Type	Responsible Organization(s)
Notional Unit Composition (GCE)	MCCDC, CDD, TFSD
Notional Unit Composition (non-GCE)	MCCDC, CDD, TFSD
USMC Unit Employment Schedule, by MCO	PP&O (TPFDDs), MCCDC G-3/5 (SSSPs)
Battle Type Characteristics	MRP AWG
USMC Weapons and Rounds with Combat Loads	I&L or TECOM
Round Characteristics	MRP AWG
Ancillary Rounds	MRP AWG
Power Ratings for USMC Weapons, by MCO	MRP AWG, OAD
Repairing Losses of USMC Weapons	I&L
Rounds Expended Against False Targets Per Round Expended Against Valid Targets, by MCO	OAD

WRMR Model Input Data Type	Responsible Organization(s)
Logistics Losses, by MCO	I&L
Rounds for Special Operations	I&L
Allocation of Targets to Weapon-Round Combinations, by MCO	MRP AWG
Expenditures per Target Kill and Target Reconstitution Rates	OAD (using JWES), DIA
Target Power Ratings, by MCO	OAD
Percentage of Weapons Registered per Day	MRP AWG
Rounds per Registration	TECOM
Zeroing Expenditures	TECOM
Obstacles Created per Day per Infantry Company in Contact	TECOM and/or Operational Advisory Group (OAG)
Expenditures per Obstacle Created	TECOM and/or OAG
Obstacles Breached per Day per Infantry Company in Contact	TECOM and/or OAG and/or PP&O, G-3/5
Expenditures per Obstacle Breached	TECOM and/or OAG and/or PP&O, G-3/5
Explosive Ordnance Disposal Expenditures	TECOM and/or OAG and/or PP&O, G-3/5
Rear-Area Security Expenditures per Weapon per Day	PP&O (TPFDDs), G-3/5 (SSSPs)
Self-Defense Expenditures per Weapon per Day	PP&O (TPFDDs), G-3/5 (SSSPs)
Expenditure Overrides for Self-Defense	PP&O (TPFDDs), G-3/5 (SSSPs)
Minutes of Illumination Needed per Day	PP&O (TPFDDs), G-3/5 (SSSPs)
Minutes of Illumination Provided per Round	TECOM
Minutes of Obscuration Needed per Day	PP&O (TPFDDs), G-3/5 (SSSPs)
Minutes of Obscuration Provided per Round	TECOM
Screening Episodes per Vehicle per Day, by MCO	MRP AWG
Rounds Expended per Screening Episode	TECOM
Mine Expenditures per Infantry Company in Contact per Day, by MCO	PP&O (TPFDDs), G-3/5 (SSSPs)
Command and Control Expenditures per Day	PP&O (TPFDDs), G-3/5 (SSSPs)
Effectiveness and Kills for Suppressive Expenditures	OAD and/or PP&O (TPFDDs), G-3/5 (SSSPs)
CO/FP Capabilities - Notional units and days of expenditures	PP&O
SR Capabilities - Notional units and days of expenditures	PP&O
Future Deployed/Retired Weapons	MARCORSYSCOM
Future Deployed/Retired Munitions	MARCORSYSCOM
Training Requirements	TECOM
Testing Requirements	MARCORSYSCOM
Title 10 Requirements	PP&O (international obligations), TECOM (training obligations)
Munition Inventories, by year	MARCORSYSCOM
Target Quantities	DIA
Percentage of Targets to be Destroyed	COCOMs
Target Cluster Parameters (% of targets destroyed during each period of combat)	OAD
Indirect-fire Target Templates	MCIA
Expenditure Thresholds	OAD
Fully-Engaged Shooter Parameters	OAD
Employment Percentage Adjustment Parameters	MRP AWG and/or OAD
Target Exposed/In-Defilade Parameters	OAD and/or PP&O (OPLANs), G-3/5 (SSSPs)
Target Reconstitution (ie Recoverability) Parameters	MCIA

Table 9-1: Proposed Organizations to Support WRMR Model Data Develoment

9.3 The MRP from an Execution Perspective

This section provides a task-based timeline of a representative MRP cycle based on the most recent proposed revision of DoDI 3000.4 and the observations, determinations and recommendations of this study. All inter-organizational requests for support or data by all Marine Corps organizations represented in the timeline should be accomplished through the development of an MCATS tasker.

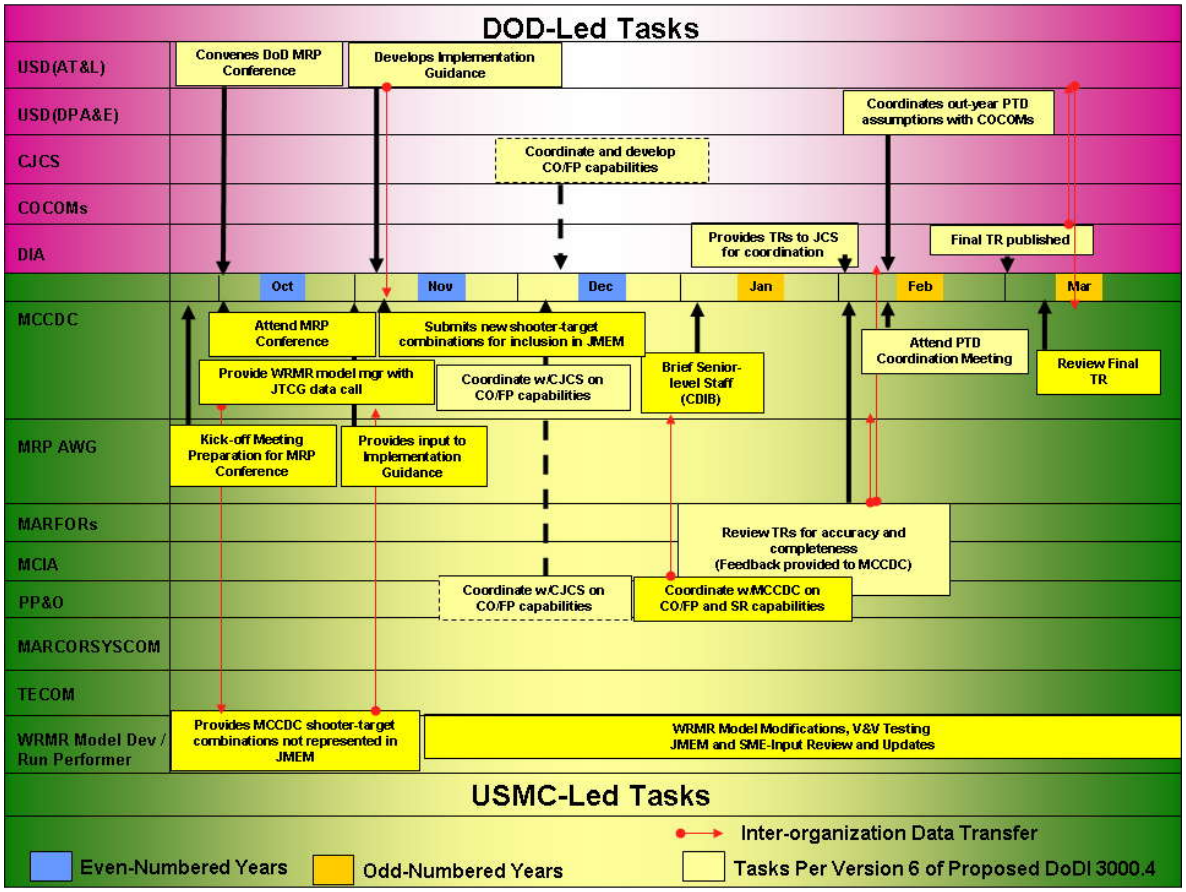

Figure 9-2: Proposed Task and Workflow for USMC MRP (1 of 4)

September through December – Even-Numbered Years

September (early) – MCCDC reviews/updates MCO 8000.7

Prior to the start of a new MRP cycle the ARO reviews the current MCO 8000.7 or its successor to establish compliance and alignment with the current DoDI 3000.4 and other DoD guidance, ensure that the roles and responsibilities of the various Marine Corps organizations are still relevant, and determine that it encompasses all tasks necessary to develop an analytically sound and defendable TMR.

September (late) – MCCDC convenes MRP AWG to prepare for USD (AT&L) PTD/MRP Kick-Off Meeting.

In early September, the MCCDC ARO should send an MCATS tasker announcing the upcoming MRP study, identifying members of the MRP AWG, and informing them of the roles and responsibilities of the MRP AWG in supporting the Marine Corps ground ammunition requirements process. (See section 9.2 for a proposed list of organizations to be members in the MRP AWG.)

As personnel changes likely will have occurred since the previous MRP, this meeting should review the methodologies and results of the last MRP performed, review the roles and responsibilities of each of the organizations in supporting the MRP, and define a list of concerns or issues that is to be presented at the October PTD/MRP Kick-Off Meeting.

This initial meeting could also include organizations that have been assigned the responsibility for reviewing and updating any portion of the WRMR model exhibits. By incorporating a review process at this time, the MCCDC ARO ensures that all non-DoD data required by the model is valid prior to the start of the MRP.

Although this is not represented on the timelines, the MRP AWG could meet at least quarterly to review the status of the current MRP and identify upcoming tasks.

Early October – USD (AT&L) convenes a PTD/MRP Kick-Off Meeting, attended by MCCDC ARO.

This meeting is used to review anticipated changes in guidance and procedures affecting the MRP and/or resolve any MRP issues that may have been encountered the previous cycle. This provides MCCDC the earliest opportunity to present any issues identified by the MRP AWG to a combined audience representing DoD, the Services and the COCOMs.

Informed by this study, items that the Marine Corps representative should ask that the group address the need to:

- Have the requirements for the COCOM-generated near-year PTDs be performed in a consistent and analytically sound manner due to the fact that the ground force apportionment of the out-year PTD is derived directly from the near-year PTD;

- Have the PTDs include the TPFDD/force flow date of records;

- Have targets for rotary-wing aircraft be defined separately from the targets for Marine ground forces in the PTD;

- Have the PTD spreadsheets be accompanied by documentation indicating the assumptions used, including whether repair of assets was modeled by the COCOM, the TPFDDs/force flow documents used, as well as any modifications to the OPLAN/CONPLAN used; and

- Have the ABL for each COCOM residing on the JDS web site include the OPLAN/CONPLAN and theater analysis depicting an anticipated scheme of maneuver and timing of such maneuvers.

October – MCCDC sends request for information from JTCG/ME to WRMR model maintenance team. WRMR model team provides list of data elements not currently represented in JMEM.

Upon receipt of the annual request for modifications and comment on the JMEM/Surface-to-Surface capabilities and database, the ARO should pass this request to the maintainers of the WRMR model. The WRMR model team then should evaluate the current database to determine identify and prioritize important shooter-target pairings not currently represented in the JMEM database and for which no valid surrogate exists. This list should then be returned to the ARO for electronic submission to the JTCG/ME working group.

October – Coordinate with USD (AT&L) on Implementation Guidance. Coordinate with CJCS on CO/FP capabilities.

USD (AT&L), in coordination with USD(P), develops Implementation Guidance. This guidance is coordinated with the MRP Working Group. As a member of this working group, MCCDC is able to ensure that detailed guidance regarding scenarios is provided and the the scenarios selected portray an acceptable level of Marine involvement.

Per version 6 of the proposed revision of DoDI 3000.4, the CJCS is tasked with defining the CO/FP capabilities in coordination with the Services, COCOMs, and USD(P) and removes reference to SR capabilities and requirements. In a previous version of the proposed revision, development of CO/FP capabilities were the responsibility of USD(P).

Regardless of the organization that develops these capabilities, MCCDC and PP&O must review the scenarios and forces defined for the WD, SD, and CO/FP to ensure that each scenario includes a reasonable Marine Corps level of effort. Scenarios in which no USMC forces are present, or in which forces are included but not expected to engage the enemy, should not be selected for requirements analysis.

If, as in past years, specific CO/FP guidance is not provided, MCCDC should be prepared to coordinate with PP&O to develop a reasonable set of CO/FP forces. These forces could be derived from the MSFDs of scenarios defined in the SSSP scenarios aligning the Marine process with the requirement to utilize the Analytical Agenda per version 6 of the proposed revision of DoDI 3000.4.

November – May – WRMR model modifications, VV&A, JMEM and SME-supplied data updates.

During the period from November of even-numbered years the WRMR model developers are not tasked with performing runs to support TMR development or supporting sufficiency analysis. This time should be utilized to make necessary modifications and perform

maintenance of the model source code. Testing should be performed to ensure that each of the interfaces and analysis reports generated by the model still perform correctly. Verification and validation tests should be performed on any code modifications. In addition, JMEM data and SME-supplied inputs should be reviewed for completeness and accuracy, with changes being made and documented as necessary.

December – Brief senior-level staff.

As previously noted in this report, it was suggested that a senior-level board review and validate the inputs. Furthermore, it was suggested that the CDIB would be an acceptable review board to perform this role. Thus, the briefing represented here would likely be presented to the CDIB.

This briefing would incorporate a quick review of the tasks and timeline associated with the MRP, and detail the guidance pertaining to scenarios as described in the USD (AT&L) Implementation Guidance, and the and CO/FP capabilities as defined by the CJCS or MCCDC in coordination with PP&O.

January through December – Odd -Numbered Years

February 1 – DIA provides near- and out-year TRs to Chairman of the JCS for coordination. USMC coordinates on the review process.

On February 1, DIA provides TRs consisting of Threat Assessments and JCOFAs to USD (AT&L) for dissemination to the CJCS, COCOMs, and Services. These documents should be reviewed for accuracy and completeness by MCIA, PP&O, and the relevant MARFORs. Any issues or comments should be presented to the MRP Working Group, the COCOMs, or DIA. These Marine corps organizations should also notify MCCDC of any issues or concerns with the TR as well as any modifications to the final TR that are made based on DIA addressing these issues.

Mid-February – PTD Coordination Meeting.

The MCCDC ARO should attend this meeting to review the COCOMs' assumptions and methodologies. Since the JCS uses the COCOM's near-year PTDs to define the out-year apportionments for ground forces, the MCCDC ARO should have a thorough understanding of the COCOMs' methodologies and assumptions, and should verify that issues presented at the October PTD/MRP Kick-off Meeting relating to near-year PTD development have all been addressed.

March 1 – Final DIA TRs released.

On March 1, the final DIA TRs should be provided to USD (AT&L) for dissemination to the MRP Working Group. The MCCDC ARO should review this final document to ensure that any issues identified during the February review of this document by the Marine Corps have been properly addressed.

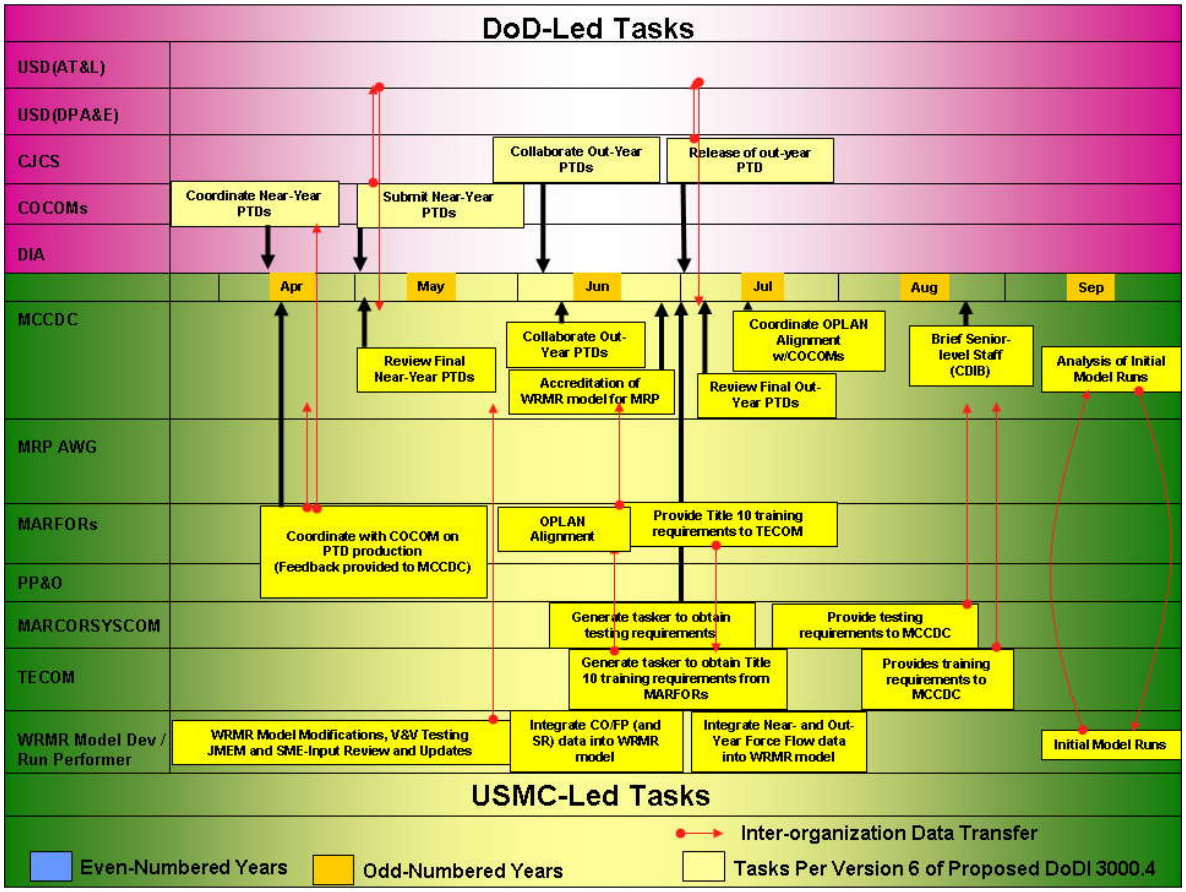

Figure 9-3: Proposed Task and Workflow for USMC MRP (2 of 4)

April – Coordination of near-year PTDs.

Each of the COCOMs should release a draft near-year PTD in April for coordination with each of the Services. The relevant MARFORs and PP&O should review these PTDs for accuracy and completeness. Any issues or concerns identified during this review should be provided to the COCOMs and to the MCCDC ARO. Modifications to the PTDs resulting from this process should also be noted and presented to the MCCDC ARO.

May 1 – Final near-year PTDs released.

The COCOMs are required to submit the near-year PTDs to DoD by May 1, after which they are released to the Services. The MCCDC ARO should review each of the near-year PTDs to ensure that all issues identified by the MARFORs and PP&O during coordination with the COCOMs have been addressed.

May – WRMR model developer submits WRMR model updates and V&V testing documents to MCCDC.

Upon completion of model modifications, the WRMR model developer should submit a

report detailing any changes to the model as well as the V&V testing performed to ensure the modifications have been coded correctly and provide accurate requirements estimates.

Analysis of the changes should be performed either by the civilian representative supporting the MCCDC ARO (if this position has been created and filled as recommended in this study) or by OAD. This analysis should verify that the model is operating properly, that all changes to data files are properly accounted for in the graphical user interface. It should estimate the impacts on the final values generated for the TMR.

June – Accreditation of the WRMR model for use in the MRP.

If changes have been incorporated into the WRMR model the ARO should have the model re-accredited for use in developing the TMR. The MCCDC Senior Analyst should perform this accreditation.

June – Coordination of out-year PTDs.

The CJCS, through J-8 FAED, should release draft out-year PTDs in June for coordination with each of the Services. The relevant MARFORs and PP&O should review these PTDs for accuracy and completeness. Any issues or concerns identified during this review should be provided to the COCOMs and to the MCCDC ARO. Modifications to the PTDs resulting from this process should also be noted and presented to the MCCDC ARO.

June – OPLAN alignment by MARFORs.

The MARFORs should coordinate with MCCDC and PP&O to define the phases and postures to be used in the WRMR model designed to represent their respective COCOM's scheme of maneuver and anticipated timing of operations.

July 1 – Final near-year PTDs released.

The CJCS is required to submit the out-year PTDs to DoD by July 1, after which they are released to the Services. The MCCDC ARO should review each of the out-year PTDs to ensure that all issues identified by the MARFORs and PP&O during coordination with the COCOMs have been addressed.

July – Coordinate OPLAN alignment and MRP methodologies with COCOMs.

The MCCDC ARO, via a video-teleconference or other means, should provide a briefing to each of the COCOMs explaining the Marine Corps MRP, including all assumptions and methods used to calculate the TMR. This briefing could also include the OPLAN alignment developed by the MARFORs, allowing the COCOMs to validate this data. This coordination of the Services' MRP methods with the COCOMs is a defined requirement in the 2003 DoDI 3000.4 as well as all proposed revisions to this instruction.

Late June to Early July – Taskers developed to obtain testing and Title 10 training requirements.

During the summer of odd-numbered years, MARCORSYSCOM should submit a tasker to the munitions managers requesting submission of testing requirements. TECOM should also submit a tasker to each of the COCOMs requesting Title 10 training munitions requirements representing the munitions provided to allied forces during combined training exercises.

June to August – Organization responsible for WRMR model runs integrates CO/FP capabilities, DoD and OPLAN alignment data into the model database.

In preparation for initial model runs, the organization responsible for WRMR model runs integrates all data into the database. This data includes the forces and days of assault/sustained rates of fire for CO/FP calculations, testing and training data provided by MARCORSYSCOM and TECOM, respectively, the OPLAN alignment data submitted by the MARFORs, target information provided in the near- and out-year PTDs, as well as force flow information that is consistent with that used by the COCOMs in development of the near-year PTD and J-8 WAD in development of the out-year PTD.

August – Brief CDIB.

After all data has been received, but prior to initial model runs, the MCCDC ARO should again brief the CDIB on all developments, including modeling and data assumptions, affecting the development of the TMR. The CDIB should review and validate these modeling and data assumptions to ensure accuracy and completeness.

August – MARCORSYSCOM provides testing requirements to MCCDC.

August – TECOM provides training requirements to MCCDC.

September – October – Initial model runs and analysis.

During the months of September and October, the organization responsible for WRMR model runs should perform runs which will then be analyzed, likely a coordinated effort between representatives of MCCDC LID, OAD, and the organization performing the model runs. This analysis should focus on finding and addressing erroneous results that may be due to incorrect data inputs or methodologies. Once the final model run for the draft TMR is performed, an analysis of specific DODICs should be performed to identify causes for changes from previous years' requirements. If time prevents such analysis on all DODICs, it is suggested that it be performed on all priority targets as defined by MARCORSYSCOM, the DODICs representing the greatest cost in the TMR, and all DODICs which experience a significant year-to-year change.

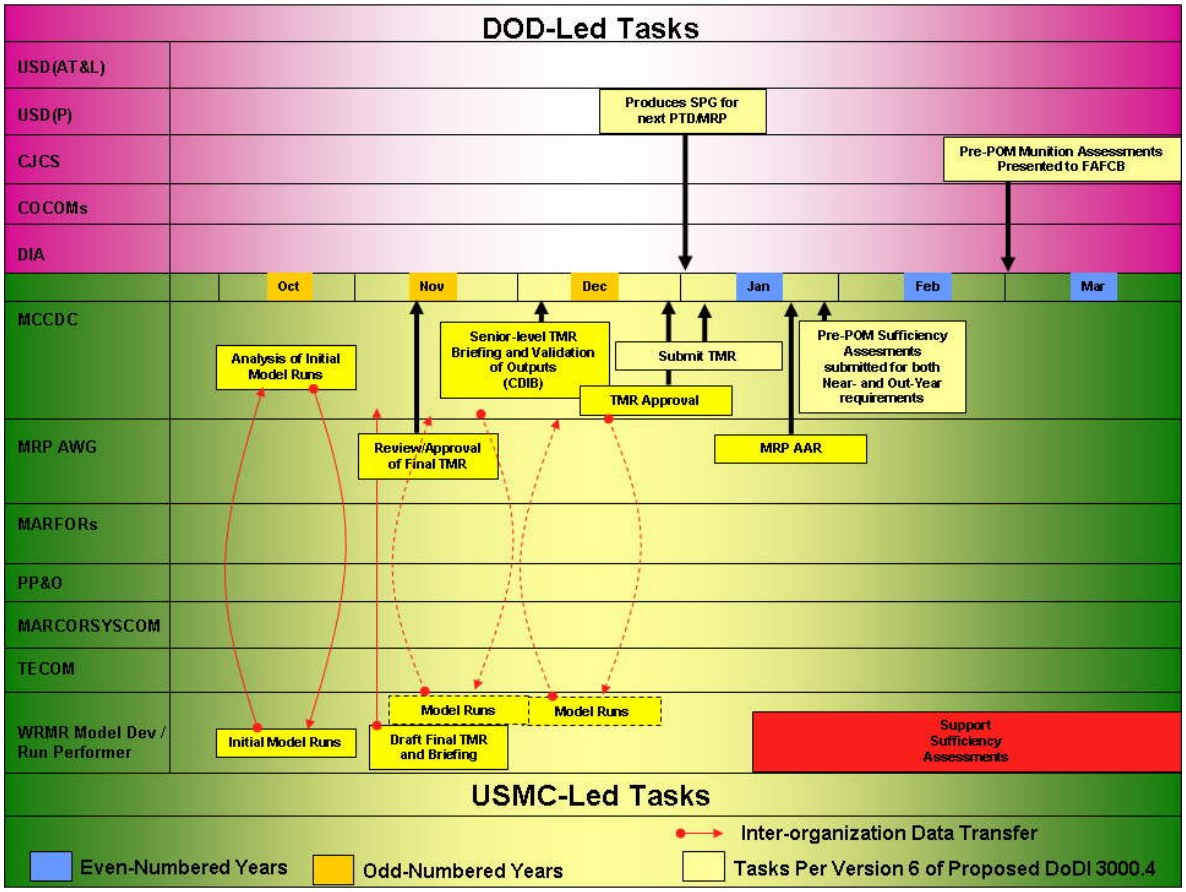

Figure 9-4: Proposed Task and Workflow for USMC MRP (3 of 4)

November – Review / Approval of TMR by MRP AWG members.

After representatives from LID and OAD determine the draft TMR is acceptable, the ARO should brief the MRP AWG and submit the draft TMR for their approval. The briefing should provide the necessary background on the methodologies and assumptions used to generate the TMR and include historical comparisons, by DODIC, with the reasons for major changes in specific DODIC requirements.

If issues or problems are identified by the MRP AWG members, it may be necessary to perform additional model runs to address these problems. After each additional run, analysis should again be performed to verify the results accurately reflect the changes made.

December – Review / Approval of TMR by CDIB.

After all issues noted by the MRP AWG have been addressed, the CDIB should again be briefed. This briefing will likely be similar in content to that provided the MRP AWG. If the CDIB identifies problems with the TMR, additional model runs may have to be performed, again being accompanied by an analysis of the results.

Late December – Staffing and final approval of TMR.

After the MRP AWG and the CDIB have reviewed and validated the draft TMR, the ARO staffs the final TMR through MCCDC's Senior Analyst and the commander of MCCDC LID. Again, the ARO should be prepared to respond to any issues identified by these personnel and incorporate changes into the final TMR.

Once the MCCDC Senior Analyst and commander of MCCDC LID are satisfied with the TMR, it is submitted for approval and signature to the CDD.

January through September – Even-Numbered Years

January 2 – Submission of TMR to DoD.

Late January – MRP After-Action Review (AAR) by MRP AWG.

Following the submission of the final TMR to DoD, all members of the MRP AWG should meet to perform an AAR. This meeting should identify and address problems noted with the process, methodologies, assumptions, and data used to develop the TMR. The results of this AAR should be re-evaluated during the following MRP AWG Kick-off Meeting in September.

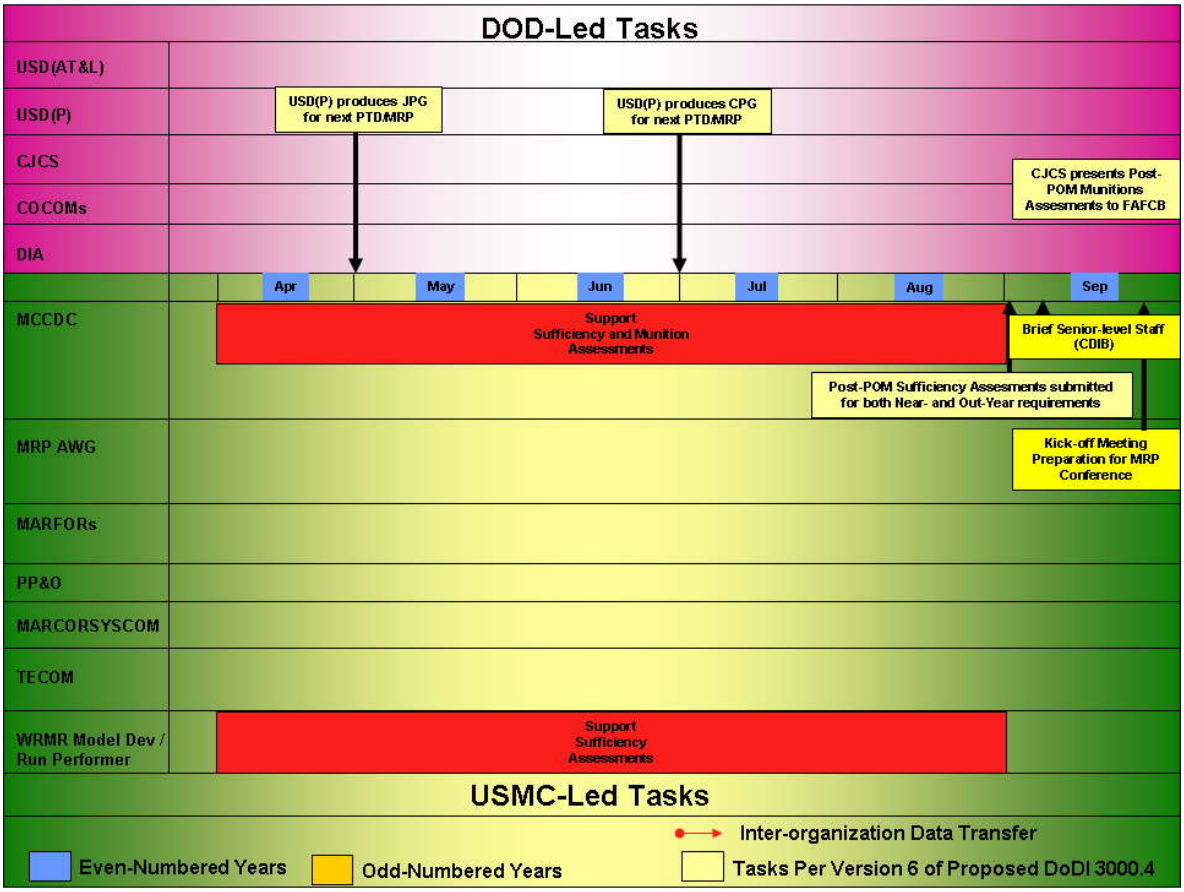

Figure 9-5: Proposed Task and Workflow for USMC MRP (4 of 4)

February – September – Sufficiency and Munitions Assessments.

Between February and September of even-numbered years, the MCCDC ARO should support the Sufficiency and Munitions Assessments required by DoDI 3000.4 as part of the MRP. These assessments are outside the scope of this report.

Appendix A. Acronyms

AAO	Approved Acquisition Objective
AAR	After Action Review
ABL	Analytical Baseline
ACM	Air Contingency MAGTF
APL	Acquisition Policy Letter
AP/AM	Anti-Personnel / Anti-Material
ARO	Ammunition Requirements Officer
ASCC	Army Service Component Commands
AT	Anti-Terrorist
AT&L	Acquisition, Technology, and Logistics
ATCAL	Attrition Calibration (Army methodology)
AWG	Ammunition Working Group
BDA	Battle Damage Assessment
BDP	Baseline Defense Posture
BE	Basic Encyclopedia
BSP	Baseline Security Posture
CAA	Center for Army Analysis
CNA	Center for Naval Analysis
CBMR	Capabilities Based Munitions Requirement
CD&I	Combat Development and Integration
CDIB	Capabilities Development and Integration Board
CED	Campaign Enablers Division
CG	Commanding General

CJCS	Chairman Joint Chiefs of Staff
CO/FPR	Current Operations/Forward Presence Requirement
COCOM	Combatant Commander
COMMARCORSYSCOM	Commander Marine Corps Systems Command
CONPLAN	Contingency Plan
COSAGE	Combat Sample Generator (Army model)
CPF	Combat Planning Factor
CPG	Contingency Planning Guidance
CR	Combat Requirement
CTEM	Conventional Targeting Effectiveness Model
DC	Deputy Commandant
DIA	Defense Intelligence Agency
DoD	Department of Defense
DoDI	Department of Defense Instruction
DODIC	Department of Defense Identification Code
DPG	Defense Planning Guidance
DPS	Defense Planning Scenarios
DTA	Dynamic Threat Assessment
EOD	Explosive Ordnance Disposal
ESCA	Executive Steering Committee for Ammunition
FAED	Force Application Engagement Division
FY	Fiscal Year
FYDP	Future Years Defense Program
GAO	Government Accountability Office, previously General Accounting Office

GAR	Ground Ammunition Requirements
GCCS	Global Command and Control System
GCE	Ground Combat Element
GTARG	Ground Training Ammunition Review Group
GWOT	Global War on Terrorism
HE	High Explosive
HQ	Headquarters
I&L	Installations and Logistics
IED	Improvised Explosive Device
IPR	In-Progress Review
ITEM	Integrated Theater Engagement Model
ITS	Individual Training Standards
JACPAT	JICM / ATCAL / COSAGE Process Action Team
JADM SC	Joint Analytic Data Management Steering Committee
JCIDS	Joint Capabilities Integration and Development System
JCOFA	Joint Country Force Assessment
JCS	Joint Chiefs of Staff
JICM	Joint Integrated Contingency Model
JMEM	Joint Munitions Effectiveness Manuals
JP	Joint Publication
JROC	Joint Requirements Oversight Council
JTCG/ME	Joint Technical Coordinating Group for Munitions Effectiveness
JWES	JMEM/Weapons Effectiveness System
KTO	Korean Theater of Operations

LAR	Light Armored Reconnaissance
LAV	Light Armored Vehicle
LFORM	Land Force Operational Reserve Material
LID	Logistics Integration Division
MACOM	Major Army Command
MAGTF	Marine Air-Ground Task Force
MARCORSYSCOM	Marine Corps Systems Command
MARFOK	Marine Forces Korea
MARFOR	Marine Forces
MARFORCENT	Marine Forces Central
MARFORPAC	Marine Forces Pacific
MCARMS	Marine Corps Ammunition Requirements Management System
MCATS	Marine Corps Action Tracking System
MCBul	Marine Corps Bulletin
MCCBMRP	Marine Corps Capabilities-Based Munitions Requirements Process
MCCDC	Marine Corps Combat Development Command
MCCS	Marine Corps Common Skills
MCIA	Marine Corps Intelligence Activity
MCO	Marine Corps Order
MCOTEA	Marine Corps Operational Test and Evaluation Activity
MCPP-N	Marine Corps Pre-Position - Norway
MCSC	Marine Corps Systems Command
MCTIMS	Marine Corps Training Information Management System
MEB	Marine Expeditionary Brigade

MEF	Marine Expeditionary Force
MFE WRS-I	Marine Forces Europe War Reserve Stock - Israel
MOUT	Military Operations in Urban Terrain
MP	Military Police
MROC	Marine Requirements Oversight Council
MRP	Munitions Requirements Process
MSFD	Multi-Service Force Deployment
MUREP	Munitions Report
NAS	Naval Audit Service
NGIC	National Ground Intelligence Center
NNOR	Non-Nuclear Ordnance Requirement
OAD	Operations Analysis Division
OAG	Operational Advisory Group
OEF	Operation Enduring Freedom
OGRE	Order of Battle Generation and Relation Engine
OIF	Operation Iraqi Freedom
OPLAN	Operational Plan
OSD	Office of the Secretary of Defense
P&R	Programs and Resources
PA&E	Program Assessment and Evaluation
PACOM	U.S. Pacific Command
PDF	Portable Document Format
POI	Programs-of-Instruction
POM	Program Objective Memorandum

PP&O	Plans, Policies and Operations
PPL	Peacetime Pipeline
PR	Program Review
PTD	Phased Threat Distribution
QWARRM	Quantitative War Reserve Requirements – Munitions (Army process)
RRMS	Requirements Related Munitions Stock
SAC	Study Advisory Committee
SD	Swiftly Defeat
SIPR	Secure Internet Protocol Router
SME	Subject Matter Expert
SOC	Special Operations Capable
SOF	Special Operations Forces
SPG	Strategic Planning Guidance
SQL	Structured Query Language
SRR	Strategic Readiness Requirement
SSSP	Steady-State Security Posture
STORM	Synthetic Theater Operations Research Model
T&R	Training and Readiness
TAMIS-R	Training Ammunition Management Information System – Redesigned
TCR	Total Combat Requirement
TECOM	Training and Education Command
TECOMO	Training and Education Command Order
TFSMS	Total Force Structure Management System

TFSD	Total Force Structure Division
TMR	Total Munitions Requirement
TPFDD	Time-Phased Force Deployment Data
TR	Threat Report
TRADOC	Training and Doctrine Command
TTP	Tactics, Training, and Procedures
TTR	Training and Testing Requirement
UDP	Unit Deployment Program
USAIC	United States Army Infantry Center
USD	Under Secretary of Defense
USFK	United States Forces Korea
USMC	United States Marine Corps
USSTRATCOM	United States Strategic Command
V&V	Verification and Validation
VV&A	Verification, Validation, and Accreditation
WAD	Warfighting Analysis Division
WD	Win Decisive
WMD	Weapons of Mass Destruction
WRMR	War Reserve Munitions Requirements

Appendix B. Glossary

Approved Acquisition Objective	The quantity of an item authorized for peacetime and wartime requirements to equip and sustain US and allied forces, according to current DoD policies and plans. That quantity shall be sufficient to support other U.S. Government Agencies, as applicable.
Ammunition Working Group	A formal policy advisory group to the ESCA, the AWG develops and evaluates new approaches for improving the munitions requirements process. The AWG also evaluates the impact that current and future budgetary constraints may have on Marine Corps Capabilities.
Analytical Agenda	An effort designed to collect, develop, maintain and disseminate data on current and future US and non-US forces and scenarios in support of strategic analysis.
Analytical Baseline	A package comprising a scenario, concept of operations, and integrated data used by the DoD Components as a foundation for strategic analyses. Examples of analytical baselines include scenarios and supporting data used for computer-assisted war games and theater campaign simulations.
Basic Encyclopedia (BE)	A compilation of identified installations and physical areas of potential significance as objectives for attack. An alpha-numeric identifier, commonly referred to as the BE number, is assigned to each of these installations.
Assault Rate	Daily expenditure rate computed in the WRMR model for a munition that is attainable for limited durations during high-intensity conflicts.
Class V(W)	The class of supply representing ground ammunition.
Combat Load	The standard quantity and type of munitions carried by a weapons platform and or its dedicated support vehicle.
Combat Planning Factor	Calculation reflecting anticipated expenditures of ground ammunition over designated time periods of combat/contingency operations. Used in conjunction with a force structure, weapons mix, combat intensity, and scenario durations, to provide an anticipated requirement.

Combat Requirement	The quantity of munitions required to equip a specified force structure to perform its assigned military mission and to meet combatant command objectives.
Constrained Requirement	Implemented only for the near-year, it is a set of requirements limited by projected inventories.
Contingency Planning Guidance (CPG)	This document provides guidance to the combatant commanders concerning contingencies and includes the Prioritized Regional Objectives for DoD.
Current Operations/Forward Presence Requirements	The sum of munitions required to arm forces to conduct current operations and meet forward presence obligations in accordance with DoD guidance. Forward presence includes Global Naval Force Presence Policy and operations that the President directs.
Data	A representation of facts, concepts, or instructions in a formalized manner suitable for communication, interpretation, or processing by humans or by automatic means. Assumed, given, measured, or otherwise determined facts or propositions used to draw conclusions or make a decision.
Data V&V	The process of verifying the internal consistency and correctness of data and validating that it represents real-world entities appropriate for its intended purpose or an expected range of purposes.
Defense Planning Guidance (DPG)	The DPG presents the Secretary of Defense's strategic plan for developing and employing future forces.
Defense Planning Scenarios	Provides a depiction of a threat to international security, a corresponding mission for U.S. military forces, and a strategic-level concept of operation for carrying out that mission. The SECDEF approves a single set of scenarios intended to serve as a standard by which the senior leadership of the Department can gauge the sufficiency of the Defense Program. A single set of scenarios ensures DOD consistency for studies, war games, and experimentation.
Department of Defense Identification Code (DODIC)	A four-digit alpha-numeric identifier assigned to each type of ammunition.

Dynamic Threat Assessment	Previously referred to as a Threat Report, it is a collection of quantitative and qualitative assumptions, estimates, and facts about the threat specified in the current DPG(SPG)/CPG, that US and allied forces may face during the near-year and out-year period. The report presents the Defense Intelligence Agency's (DIA) estimate of enemy capabilities in three levels of detail ranging from type and numbers of weapons to an analysis of expected trends in modernization of weaponry and force structure.
Executive Steering Committee for Ammunition	A committed composed of CG MCCDC, the Deputy Chief of Staff for PP&O, I&L, Aviation, and P&R, as well as the COMMARCORSYSCOM which is responsible for establishing ammunition policy within the Marine Corps munitions requirements process and approves policy recommendations for ammunition issues formulated by the AWG.
F-Kill	A firepower kill referring to damage inflicted by a weapon on a vehicle to a level that destroys its weapon systems, or substantially reduces its ability to deliver weapons accurately.
Ground Combat Element Forces	The Marine air-ground task force (MAGTF) element that is task-organized to conduct ground operations.
Joint Country Force Assessment	A database of non-US force structure and equipment, projecting 20 years into the future. The JCOFA currently maintains data on 21 countries and updates on each country are performed every two years.
K-Kill	A catastrophic or complete kill referring to damage inflicted on a vehicle by a weapon to a level that renders it both unusable and unrepairable.
M/F-Kill	A mission kill, meaning a mobility kill, firepower kill, or both, in which a military vehicle is not destroyed but is damaged by a weapon to a level that prevents it from taking further part in its intended mission.
M-Kill	A mobility kill referring to damage inflicted by a weapon on a vehicle to a level that immobilizes it, but does not totally destroy it, leaving the vehicle's crew able to use its weapons.
Multi-Service Force Deployment (MSFD)	Built upon DPS guidance, the MSFD provides detailed friendly and enemy CONOPS, as well as a listing of the required forces for the directed DPS scenario.
Munitions	Ammunition or ordnance, including rockets, missiles, projectiles and bombs.

Munitions Requirements Process	A biennial process performed by each of the Services to estimate the quantity of each type of munition required to support combat operations as defined in the current CPG. The munitions requirements shall address the operational objectives of the COCOMs against potential threats, consider logistics capabilities, and retain residual capability and support CO/FPR at the end of any major combat operation.
Near-Year	October 1 of the year following the calendar year the Service DoD MRP requirements are submitted (i.e., if DoD MRP reporting is March 15, XX, then Near-year is October 1, XX+1).
Non-Ground Combat Element Forces	Any Marine forces not represented in the ground combat element (GCE) forces, including combat support services, such as transportation and medical forces.
Non-Target-Oriented Expenditures	Ammunition consumed to maintain weapon proficiency on the battlefield (i.e. registration and zeroing expenditures) or in the support of target prosecution or other combat operations (i.e. smoke, illumination, and EOD expenditures).
OPLAN Alignment	The process of ensuring that the phases of combat and timing of operational maneuvers, as represented by changes in posture, in the WRMR model input database accurately represent the COCOM's intent and reflect the OPLAN/CONPLAN analysis performed by the COCOM planning staff.
Out-Year	September 30 of the last year of the FYDP.
Peacetime Pipeline	A quantity of munitions added to the USMC training-specific munition requirements representing the estimated number of munitions that have been purchased but not yet delivered to the end users at any given time. The Peacetime Pipeline is currently defined as 313 days of training ammunition, which is the weighted average time required to deliver ammunition to Marine forces in support of training requirements.
Phased Threat Distribution	The assignment by campaign phase of a portion of the enemy's total combat capability (i.e. forces, installations, and organizations) to DoD component commands. The distribution is a percentage by type of target (e.g., tanks and fighters) by operation plan phases.
Preferred Munitions	Munitions that provide the desired probability of kill against a given target type or that significantly improve the probability of survival against the projected threat, as determined by the warfighter.

Risk Assessment	The process used to quantify the hazard to overall warfighting ability at the beginning (near-term) and end (out-year) of the future years defense plan (FYDP)
Strategic Planning Guidance	The codification of a set of future military challenges and associated key assumptions that explicitly establish DoD-wide priorities that shape future military capabilities. The SPG is being succeeded by the Guidance for the Development of the Force (GDF).
Special Operations Command Allowance	An augment of selected equipment to provide enhanced conventional and selected maritime special operations capabilities.
Steady State Security Posture	A replacement for the Baseline Security Posture, the SSSP has five strategic environments or future themes, from which to form a basis for military force requirements over time, and a menu of different surge-inducing events to overlay on those Steady-State demands.
Strategic Readiness Requirement	The quantity of munitions needed to arm forces not committed to support combat operations in the assigned MCOs, as well as those performing current operations/forward presence missions. It includes any additional munitions requirements generated from treaties or statutory obligations to allies.
Strike Favorable	Per DoDI 3000.4, one of two scenarios to be analyzed by the COCOMs in developing the PTD, it is to represent conditions favorable to the application of airborne strike platforms in the destruction of enemy targets.
Strike Unfavorable	Per DoDI 3000.4, one of two scenarios to be analyzed by the COCOMs in developing the PTD, it is to represent conditions unfavorable to the use of airborne strike platforms in the destruction of enemy targets, thereby placing a greater requirement on the friendly ground forces.
Subject Matter Expert	An individual who, by virtue of education, training or experience, has expertise in a particular technical or operational discipline, system or process.
Sustained Rate	Daily expenditure rate for a munition computed in the WRMR model that will be maintained for an indefinite length of time until all campaign objectives are accomplished.

Swiftly Defeat	To achieve a circumscribed set of objectives aimed at altering an adversary's behavior or policies, swiftly denying an adversary's operational or strategic objectives, preventing attacks or uncontrolled conflict escalation, and/or rapidly reestablishing security conditions favorable to the United States and its partners.
Target-Oriented Expenditures	Ammunition consumed in the prosecution of targets and which cause attrition to those targets.
Threat Reports	A collection of quantitative and qualitative assumptions, estimates, and facts about the threat specified in the current DPG/CPG, that US and allied forces may face during the near-year and out-year period. The information presents the Defense Intelligence Agency’s (DIA) estimate of enemy capabilities in three levels of detail ranging from type and numbers of weapons to an analysis of expected trends in modernization of weaponry and force structure.
Title 10 Requirement	Ammunition requirements mandated by the federal government, usually in association with treaty obligations with allied nations.
Total Munitions Requirement	The sum of war reserve munitions requirement and the training and testing requirement.
Training and Readiness Manual	Document establishing the training standards used by unit commanders and school directors to design, develop, conduct and evaluate the individual training of Marines.
Training and Testing Requirement	Munitions required to train the force and support military Service programs ensuring that weapons and platforms deliver the intended effectiveness (can be stated as an annual requirement, a future years defense program requirement, or projected life cycle of each munitions). Surveillance, acceptance testing and production losses of munitions are accounted for in this category.
Unconstrained Requirement	The munitions requirement, not limited by projected inventory or funding. However it may be limited by: 1) reasonable production capacity (e.g., no production line exists for a legacy weapon); 2) weapon system capabilities (e.g., only one platform type has the ability to employ a weapon at that time, so it is not utilized by other platform types) and; 3) externally defined caps on procurement.

War Reserve Munitions Requirements	The sum of the combat requirement (CR), and current operations/forward presence requirement (CO/FPR) and strategic readiness requirement (SRR).
War Reserve Munitions Requirements Model	A discrete decision support tool used to generate ammunition requirements for the Marine Corps. The model uses information on threat capabilities, time-phased force deployment and weapons effectiveness to determine ammunition requirements.
Win Decisive	Campaigns undertaken to bring about fundamental, favorable change in a crisis region and create enduring results. They may entail lengthy periods of both major combat and stability operations; require regime change, defense, or restoration; and entail significant investments of the nation's resources and time.

Appendix C. Bibliography and Notes

Akst, George. (2007, October). ***Marine Corps War Reserve Munitions Requirement (WRMR) Model, Version 2.3, Accreditation*****.**

This letter accredited the WRMR model, based on the recommendations and findings presented in the V&V study of the WRMR model, for use in the development of the TMR in support of the POM-10 process. It additionally noted, that the model will continue to undergo improvements, and that this comprehensive ground ammunition study is being performed and that applicable findings from this study will be used to improve the WRMR model.

Barack, Maj Peter. (2008, January). ***Comments matrix for DoD issuances: DoD Joint action folder 07-05028 formal coordination of the DoDI 3000.4, DoD munitions requirements process (DoD) MRP.***

This document represents the official USMC response to 12 deficiencies noted in the proposed DoDI 3000.4. Major issues were addressed as follows:

- Request expanded definition of guidance be provided by AT&L to ensure Services utilize a like set of assumptions for CO/FPR and SRR calculations.
- Request clear guidance be provided regarding methodology to produce near-year PTDs, similar to the guidance provided for development of out-year PTDs.
- Notes that the definition of "Unconstrained Requirement" appears in Enclosure 2 (Definitions), but that a definition of "Constrained Requirement" does not. Questions the validity of "constrained requirement" given that the requirement is developed based on a target set to be destroyed. A constrained requirement, therefore, would not allow for complete destruction of the target set to be destroyed.
- Notes that the current Implementation Guidance does not provide guidance with respect to the CO/FPR or the SRR.
- Questions the methodology for determining interchangeability between weapon systems to be used for Sufficiency Assessments, and notes that this methodology does not account for non-target-oriented DODICs.
- Recommends the addition of a logistical pipeline for training items that do not have a WRMR, and that this pipeline be defined as up to one additional year's requirement dependent upon production and delivery lead times.
- Notes that the "Combat Requirement" label is merged over columns 3a, 3b,

and 4 instead of only 3a and 3b.

- Notes that Tier 3 of the TR must account for field fortifications that consume ammunition but are not existent prior to initiation of the conflict.
- Reinforces recommendation #11 with respect to paragraph E6.3, again noting field fortifications not being defined in the TR.

Brown, LtCol Kevin. (2007, October). ***Ground training ammunitions requirements determination briefing*****. [Powerpoint presentation].**

This briefing was provided to update MCCDC personnel on "the past, present, and future TECOM efforts in response to the 2006 Naval Audit Service report on training ammunition requirements determination methodology." A detailed examination of these steps is presented in section 7.2.4.1.

Center for Army Analysis. (2007, March). ***Deployed Analyst Handbook.***

This handbook was developed to support military and civilian analysts deploying to Iraq and Afghanistan, as well as other operational theaters. It is intended to provide a quick reference guide, presenting a wide range of topics from military symbols to specific analytical products an analyst can expect to execute. In regards to this report, it provides valuable source material when viewing the MRP through an analytical perspective, as it explains the steps in performing a study, different types of data and their relevance, many of the methods to perform analysis, and important information regarding the compilation and presentation of the results.

Commandant of the Marine Corps. (1997, 15 April). ***Marine Corps Order 8010.1E – Class V(W) Planning Factors for Fleet Marine Force Combat Operations.***

This order defines the combat planning factors to be used by operational planners and ammunition officers. These CPFs were developed during the Marine Corps Class V(W) WMR Study (1995-1996). The Marine Corps Combat Service Support School continues to teach new planners and ammunition officers that this is the authoritative source for CPFs although MCCDC has developed during the POM-10 MRP and distributed them via e-mail to the MEFs and MARFORs. See section 8 for a complete discussion of CPFs.

Commandant of the Marine Corps. (2004, October). ***MCBul 8011 (FY05) – Class V(W) Materiel Allowances for Training, Established Testing and Security.***

This bulletin, developed annually, provides "updated Class V(W) material allowances for all Marine Corps training requirements: accession; entry-level; professional development; and sustainment as well as operational, security, ceremonial and miscellaneous requirements." Chapter 2 of the document provides an exhaustive list, by DODIC, indicating the allowance to every Marine unit.

Commandant of the Marine Corps. (2008, March). ***MCO 3900.15B – Marine Corps Expeditionary Force Development System (EFDS).***

This order establishes the EFDS which "will be used to develop future warfighting capabilities to meet national security objectives. The system will guide the identification, development, and integration of warfighting and associated support and infrastructure capabilities for the MAGTF." Enclosure 5 of this order defines the mission of the Capabilities Development and Integration Board. The GAR Study Team, in section 6.4.1 of this report, suggests using this board to validate the inputs and outputs of the Marine MRP, similar to the role of the US Army's Council of Colonels.

Commander, Marine Corps Systems Command. (2007, July). ***Acquisition Policy Letter No. 1-07: Policy for Ammunition Requirements in Support of Acquisition Programs.***

This letter assigns the responsibility of compiling the testing requirements to PM Ammo of MARCORSYSCOM. By 1 August of each year, PM Ammo is to request updated munition requirements from all munition program managers throughout the Marine Corps. These PMs are required to provide this information to PM Ammo by 1 September. PM Ammo then compiles this data and provides it to MCCDC to be incorporated into the TMR. See section 4.2.5 for a complete description of this process as defined in this letter.

Commanding General, Marine Corps Combat Development Command. (1996, July). ***Class V(W) Ammunition – Approved Acquisition Objectives (AAOs).*** **[Marine memorandum].**

This letter indicates that the AAO encompasses the WRMR and TTR for each DODIC. It defines the WRMR as a compilation of the combat requirement, residual readiness requirement, and strategic readiness requirement. It defines the TTR as the sum of the testing requirement, the training requirement, and the training unique pipeline requirement.

Cusimano, COL Greg. (2006, February). ***HQ DA G-3/5/7 Army Munitions Management Office (AMMO) munitions executive summit briefing.*** **[Powerpoint presentation].**

This briefing provides descriptions and flow charts detailing the Army's development of its total munitions requirements. It also provides comparison of training and war reserve munitions requirements between FY08 and FY13.

DAMO-TA, HQDA G-3/5/7. (2007, March). ***The Army's Quantitative War Reserve Requirements for Munitions (QWARRM) Process briefing.*** **[Powerpoint presentation].**

This briefing provides a description of the Army's QWARRM process used to determine munitions requirements. A detailed description of this process, compiled

from this briefing as well as interviews with CAA and G-3/5/7 personnel, is presented in section 6 of this report.

Department of Defense. (2003, January 21). ***DoDI 8260.2 - Implementation of Data Collection, Development, and Management for Strategic Analyses.***

This instruction "implements policy, assigns responsibilities, and prescribes procedures for generating, collecting, developing, maintaining, and disseminating data on current and future US and non-US forces in support of strategic analyses conducted by the Department of Defense", and also establishes the Joint Analytic Data Management Steering Committee (JADM SC), a body designed to assist in implementing the procedures outlined in the instruction. A more detailed description of this product is provided in section 4.1.1.5.

Department of Defense. (2003, May 23). ***Regulation 4140.1-R – DoD Supply Chain Material Management.***

This regulation prescribes requirements and procedures on the uniform management of DoD materiel. An extensive document of 308 pages detailing procedures for planning, sourcing, maintaining, delivering, returning, etc. of materiel, it is used in this report only in an attempt to determine if the PPL is a DoD authorized addition to the TMR.

Department of Defense. (2003, October 24). ***DoDI 3000.4 - DoD Munitions Requirements Process (DoD MRP).***

This instruction provides DoD guidance and defines organizational roles and responsibilities associated with developing the Service munitions requirements. See section 3.2 for a detailed description of this document.

Department of Defense. (2007, January 11). ***DoDI 8260.01 - Support for Strategic Analysis.***

This instruction updates policy governing the development and management of data, tools, and analytical baselines supporting strategic analyses conducted by the Department of Defense. A more detailed description of this product is provided in section 4.1.1.5.

Department of Defense. (Undated, received by GAR Study Team 2007, October 31). ***Pre-coordination draft of DoD Instruction 3000.04 (sic)***

This instruction maintains many aspects of its predecessor. DIA will still produce a near- and out-year threat report that the COCOMs will use to generate near-year PTDs. These documents will then be used by the Joint Staff to develop the out-year PTD, and the Services will determine a munitions requirement based on the sum of combat requirements, CO/FPR, SRR, and testing & training requirements. While the detailed differences between these two documents are too numerous to

enumerate here, a few key differences will have a significant impact on the way the Marines perform their MRP tasks.

First, the proposed revision mandates the development of an MRP Working Group to be coordinated by USD (AT&L). This working group is to meet prior to the start of each PTD/MRP cycle, as well as periodically throughout the process to ensure implementation guidance is being accurately incorporated into the process. The GAR Study Team points out that this group could provide a venue for the Marine Corps to raise and address any problems with the TRs, PTDs, or Analytical Agenda in terms of the ability to support the MRP.

The proposed revision states that the Implementation Guidance provided by USD (AT&L) will define the forces to be used by each Service in estimating its SRR and CO/FPR. Currently, USMC Plans, Policy, and Operations (PP&O) performs this task.

The proposed revision requires each Service to use the Analytical Agenda in the creation of out-year PTDs and near- and out-year MRPs. D,PA&E will direct the development of the out-year PTDs as part of their Analytical Agenda Process and all assumptions and methdologies used in the analysis must be documented and consistent with the Analytical Agenda.

Finally, the proposed revision provides a more detailed description of the two-phase (pre-POM and post-POM) Sufficiency Assessment that is to be conducted by each of the Services, as well as the two-phase Munitions Assessment that is to be performed by the Joint Staff in coordination with the COCOMs.

Department of Defense. (Undated, received by GAR Study Team 2008, March 18). ***Pre-coordination draft of DoD Instruction 3000.4 version 4*****.**

A new proposed version of the instruction designated to supersede the October 24, 2003, version of this instruction. A detailed description of this document can be found in section 3.3.

Department of Defense. (Undated, received by GAR Study Team 2008, April 2). ***Pre-coordination draft of DoD Instruction 3000.4 version 6*****.**

A corrected version of version 4 of the same document. This version did not contain any significant alterations that would impact the methods described in section 3.3 of this report or that would require modifications to the GAR Study Team's recommendations.

Department of the Navy, Office of the Chief of Naval Operations. (1989, August 11). ***OPNAV Instruction 8011.9A, Non-nuclear Ordnance Requirements (NNOR) Process.***

This instruction delineates procedures, responsibilities and milestones for the Non-Nuclear Ordnance Requirements process. As with MCO 8000.7, this order is out-

of-date and is no longer directly followed. Per OPNAV N-81, this order is currently under review and an updated version is being staffed for publication.

Field, Walker. (2003, December). Marine Artillery in the Battle of An Nasiriyah. *Field Artillery Magazine*. 26-30.

An examination of the approximately 2,100 rounds fired by the 1st Battalion (Reinforced), 10th Marines in support of RCT-2's action during the Battle of An Nasiriyah between 23 March and 2 April, 2003. The article provides an overview of Marine operations during this battle, as well as lessons learned regarding artillery and combat planning factors. Figure 2 and 3 are pie charts which provide data on ammunition issued and expended, respectively, to the 1/10 in support of RCT-2. Maj. Walker indicates that different planning factors are necessary for military operations in urban terrain.

Girardini, Ken. (1991, January). *The Marines' Ground-Attack Conventional Munitions Requirements Process.* RAND.

This report describes and suggests improvements to the requirements methodologies for ground-fired conventional ammunition developed for the USMC, with the analysis focusing primarily on the shoter-oriented level-of-effort and target-oriented level-of-effort methodologies. It expanded on some of the shortfalls discussed in another RAND report, Estimating Conventional Munitions Requirements: Toward Improved Processes. Many of the identified shortfalls were later addressed by DoD in the 2003 DoDI 3000.4.

Ground Training Ammunition Review Group. (1998, August). *Report of the Ground Training Ammunition Review Group*.

In order to fully understand the current training requirements process, it is imperative to refer to the 1998 final report of the Ground Training Ammunition Review Group (GTARG). The Commandant of the Marine Corps determined that limited funding would require the Marine Corps to reduce its training budget by 5% annually from FY00 through FY05 in order to fund modernization programs. Thus, the GTARG was created to "define the most effective, efficient, and relevant ground training ammunition requirement" in an effort to reach these goals.

The GTARG, composed of ammunition and commandeering officers from the 1st, 2nd, 3rd, and 4th Marine Divisons, POE/PP&O, Training & Education Division, and headed by Brigadier General Sattler of the Joint Staff (J-34), contacted Headquarters Marine Corps, Force commanders and supporting establishment commanders throughout the Marine Corps to gather subject matter experts (SMEs). These SMEs were used to develop recommendations for adjustments in ammunition requirements for training standards and to identify new and innovative ways of using simulators that would maintain Marine Corps standards while reducing expenditures. The SMEs performed this task by reviewing, in detail, individual and

collective training standards and associated training ammunition requirements, determining the frequency of training, identifying 'core' and 'core plus' standards and validating those standards, and by reviewing standards used by formal schools.

GTARG members, after reviewing and debating the SME recommendations, then determined the overall Marine Corps training munition requirements, reducing the FY00 training expenditures from $264,872,987 to $187,640,618, or approximately 30%. These GTARG adjusted values submitted in MCBul 8011 for FY00 then became the initial baseline from which all training requirements since have been derived.

The 1998 GTARG final report proposed 18 recommendations which were intended to improve the calculation of the training ammunition requirement, improve the allocation and dispersal of training munitions, and reduce the training requirement while maintaining the training standards. These recommendations included the formation of a new GTARG in the year 2000 to determine the effectiveness of the implemented recommendations. While many of the recommendations were implemented, a new GTARG was never formed and the impacts of these recommendations have never been evaluated.

Headquarters Marine Corps. (2008, April 28). ***HQMC analytical support contract request for supporting analysis – Analysis of ground training ammunition requirements and consumption.***

This contract identifies the mission of the study as follows:

"The goal of this task is to propose a viable structure and methodology for a predictive tool for USMC training ammunition usage. This requires intensive and comprehensive analysis of historical usage data and current requirements. The contractor will analyze various unit types, identify unit-by-unit fluctuations in expenditure of USMC training ammunition over a specified time period (1-3 yrs), compare these actual expenditure numbers to training ammunition expenditure planning factors, investigate and identify causes for disparities, and identify courses of action (COA) for producing a predictive model that computes realistic training ammunition requirements based on location, unit type, pre-deployment training variables, and other factors that affect training ammunition expenditures."

The study is to be composed of five different tasks: data gathering; conduct literature review; analyze training ammunition data and identify disparities; develop COAs for a predictive training ammunition requirements model; and develop an estimated cost for executing one COA.

Holman, Barry W. (2002, October). ***Munitions Requirements and Combatant Commanders' Needs Require Linkage.*** **U.S. Government Accountability Office.**

This report to the Secretary of Defense critiqued the DoD MRP. It stated that "the

munitions requirements determination process does not fully consider the combatant commanders' preferences for munitions and weapon systems that will be used against targets identified in projected scenarios." It recommended that "the Secretary of Defense establish a direct link between the munitions needs of the combatan commands and the munitions requirements determinations and purchasing decisions made by the services." This letter lead to the development of the DoDI 3000.4 published in October of 2003.

Howell, LtCol Steve. (2008, 19 May). [E-mail to Keith Zandbergen, GAR Study Team Lead]. Marine Corps Systems Command.

Mr. Zandbergen had requested clarification of comments supplied by LtCol Howell in the government's comment matrix to IR-2 of this report. This e-mail stated:

"The problem has actually been corrected now. The current MUREP format captures the training expenditures associated with the Marines in a combat zone whereas the older version did not. The data is fed to the Joint Staff via an automated MUREP and the reporting of expenditures is now both timely and accurate."

Kassing, David; Crawford, Gordon; Girardini, Kenneth; Sumner, Gerald. (1991). *Estimating Conventional Munitions Requirements: Toward Improved Processes.* RAND.

The final report of the project, "Review and Improvement of Munitions Acquisition Process," sponsored by the Assistant Secretary of Defense for Production and Logistics. The project aimed at improving DoD processes for establishing conventional munitions requireiments. It provides an overview of the Services' methods to estimate requirements and proposes improvements. Many of the recommendations presented in this report were eventually incorporated into the MRP as defined in the 2003 DoDI 3000.4.

Klein, Steven W. (2006, July). *Funding And Management Of The Marine Corps' Ground Ammunition*. Center for Naval Analysis.

This briefing provided the results of a study intended to provide independent assessment of the process used to develop the TMR, recommend changes and improvments, and recommend actions to increase senior leadership awareness. It found that some faults in the overall process are beyond the Marine Corps' control; the Marine process is governed by two "obsolete" orders, MCO 8000.7 and MCO 8010.1E; and could not find evidence that the ESCA had ever actually met. Its recommendations included:

- Review of the MRP, clarifying the roles of all stakeholders;
- Fixing and documenting WRMR methodology;

- Performing VV&A of the models;
- Fixing the training methodology;
- Establishing realistic priorities for requirements;
- Establishing a process for evaluating risk related to different funding levels;
- Abolishing the ESCA and replacing it with a Council of Colonels;
- Providing greater visibility for ammunition issues by performing a semi-annual brief to the MROC and publishing metrics that show program status over time; and
- Revising and issuing relevant instructions, orders, and manuals.

MAGTF Staff Training Program Center. (2007, August). ***MSTP Pamphlet 5-0.3. MAGTF Planners Reference Manual.*** **Marine Corps Combat Develoment Command.**

This pamphlet contains dozens of tables, charts, and commentary to provide guidance and operational planning data to MAGTF planning officers. This report references tables 4-9, 4-11 and 4-13 which contain indirect-fire systems expenditures per day data for infantry-heavy, armor-heavy, and composite threats. In addition to these tables, this report references section 4026, paragraph g, which notes that users reference MCO 8010.1E to obtain direct-fire combat planning factors.

Marine Corps Combat Development Command. (2006, January). ***POM-08 total munitions requirements.*** **[Excel spreadsheet].**

Excel spreadsheet containing the final TMR submitted in support of the POM-08 MRP.

Marine Corps Combat Development Command. (2008, January). ***POM-10 total munitions requirements.*** **[Excel spreadsheet].**

Excel spreadsheet containing the final TMR submitted in support of the POM-10 MRP.

Marine Corps Systems Command. (2007, June 8). ***Ammunition process documentation.***

This document defines the process for determining ammunition procurement objectives. Enclosure 1 provides a brief description of the Capabilities-Based Munitions Requirements Process. Of relevance to this study is section 4.2 of this enclosure entitled *Determining Procurement Objectives.* This section discusses the contradictory nature of the DoD

and Marine guidance pertaining to the AAO, PPL, and TMR. A discussion of this issue can be found in section 5.2.4.3.

Marine Corps Systems Command. (2007, December). ***OIF expenditure summary spreadsheet.*** **[Excel spreadsheet].**

This spreadsheet detailed, by DODIC, the expended quantity, combat loss, and other expenditures by the Marine Corps during OIF I, OIF II, OIF 04-06, OIF 05-07, and OIF 06-08. This data was used to provide the historical basis of illumination and obscuration expenditures provided in section 7.2.1.2.

McLaughlin, William. (2007, October 9). [E-mail to Maj. Peter Barack]. U.S. Army Infantry Center.

This e-mail was in response to a request made by the GAR Study Team for information pertaining to the methods and their origins used to determine smoke and illumination expenditures for the US Army. Below is a quote of the relevant material from the e-mail:

"By doctrine, our mortar round mix is 70% anti-personnel/anti-materiel rounds (HE, PGMM, DPICM) + 20% smoke + 10% illum (white light and IR). Since the simulation does not account for smoke and illum rounds fired in support of the warfight, we make an assumption that all rounds are expended on the ratio of the doctrinal mix. Given an AP/AM round expended, a doctrinal portion of the smoke and illum rounds are also expended. The calculation:

For every 1 round of AP/AM expended:

[(1 round AP/AM fired) / (.7 AP/AM combat load)] = [(x rounds smoke fired) / (.2 smoke combat load)] Solving x = .286 or an Add-on of 28.6%.

[(1 round AP/AM fired) / (.7 AP/AM combat load)] = [(y rounds smoke fired) / (.1 illum combat load)] Solving y = .143 or an Add-on of 14.3%.

Depending how your smoke is distributed between white light and IR, you may choose to reflect the 14.3% accordingly. Infantry Center uses 50% white and 50% IR, thus illum-white is 7.14% and illum-IR is 7.14%.

I don't have any feedback to tell me if the methodology is right or wrong or leading to overstockage or understockage. The doctrinal ratio is from a long history of Infantry experience."

Naval Audit Service. (2006, June). ***Models Used by the Marine Corps to Determine Requirements and Budgets for Ammunition*****.**

This audit, completed in June 2006, recognized that proper Verification and

Validation (V&V) of the WRMR model had not been completed, and that MCCDC had not established the necessary management and control activities, such as policy and procedures, to develop an accurate and reliable methodology for computing training ammunition requirements. This report led to the development of the WRMR Model V&V Study Team.

Northrop Grumman. (2007a, December). ***Ground Training Ammunition Requirements Determination Process – Phase I. Task 2 – Data gathering findings*****.**

In an effort to address the concerns voiced in the 2006 NAS report, Headquarters Marine Corps, Program Assessment and Evaluation Division (HQMC, PA&E) contracted with Northrop Grumman (NG) to develop a model concept to be used in support of the ground training ammunition requirements determination process. This analysis was tasked to study the current training ammunition process and asses TECOM policy as compared with TECOM practice for computing annual training requirements. The effort was divided into three tasks, with the second consisting of reporting on data findings, therefore, this portion of the report included assessments of data sources, rules, and key elements of the process.

Northrop Grumman. (2007b, December). ***Ground Training Ammunition Requirements Determination Process – Phase I. Task 3 – Data analysis report*****.**

This document identifies the data sources that are utilized in the current TECOM requirements determination process as well as data sources that have potential for future use. This report details each data source, as well as proposing Courses of Action (COAs) and recommendations to TECOM on how to best leverage all data sources to most efficiently support the proposed Ground Training Ammunition Requirements model concept. The three courses of action include:

- Manual export from documents – This would require manually transfer of data from T&R Manuals, MCBul 8011, Training Input Plans, and POIs/CDDs which are currently maintained in a PDF format.

- Utilize MCTIMS – This requires the development of SQL queries to extract required data from the MCTIMS database prior to the development of PDF versions of training plans, MCBul 8011, etc. The results of these queries are then provided to the G-4 which initiates the G-4 training ammunition allowances definition process.

- Link directly to MCTIMS – Provide G-4 a pre-defined set of SQL queries required to extract the relevant data from the MCTIMS database. G-4 would then execute the queries and initiate the training ammunition allowances definition process.

COA 2 was recommended for implementation by the study team.

Northrop Grumman. (2007c, December). ***Ground Training Ammunition Requirements – functional requirements document.***

This document provided the functional requirements for the development of a TECOM model that would support development of the TTR. It indicated that the model would be composed of three modules: an unconstrained computation module; a constrained computation module, and an MCBul 8011 module. The unconstrained computation module would be designed to calculate the TTR. The constrained computation module would allow the user to define a percentage of constraint on sustainment training, entry-level and formal school training, marksmanship/common skills training, and exercise support requirements, but not on the previously established allowance requirements. The MCBul 8011 module would compile ammunition allowances by unit after the training requirements and allowances are finalized by analysts and SMEs.

Oster, J.W. (1997, June). ***Commandant's decision on the ammunition approved acquisition objective.*** **[Marine Corps memorandum].**

This memorandum defined the Approved Acquisition Objectve for conventional munitions as follows:

For training unique items the AAO = PPL.

For War Reserve only items the AAO = WR.

For dual purpose items the AAO = WR + PPL

This memorandum also indicated that the Commandant approved that the PPL be set at 313 days.

Quantics, Inc. (2007). ***USMC WRMR process validation surveys.*** **[Word document and Excel spreadsheet]. 1-28.**

This collection of 28 surveys was developed during the early stages of the WRMR model V&V effort. Intended to obtain feedback from subject matter experts, it was determined that this methodology would be too time consuming and were, therefore, never distributed. Each survey is composed of two distinct parts. The first part defines the methodology currently used in the WRMR model for making various calculations that contribute to the total munitions requirements. The second part consisted of the questionnaire that was to be distributed to the SMEs. Each document was accompanied by a spreadsheet detailing the current SME-supplied values being used in the WRMR model.

Sections 4.2.1, 4.2.2, 4.2.3 and their sub-sections were derived primarily from these sources. They provide a detailed examination of a number of these surveys.

Secretary of the Navy. (1999, April 19). ***SECNAV Instruction 5200.40 – Verification, Validation, and Accreditation (VV&A) of Models and Simulations.*** **Department of the Navy.**

This instruction establishes policy and procedures for VV&A of all models and simulations used within the Department of the Navy. It is one of three instructions that define the core of the Navy's modeling and simulation VV&A policy. SECNAV Instruction 5200.38A, dated 28 February 2002, establishes policy and procedures for all Department of the Navy modeling and simulation. OPNAV Instruction 5200.34, dated 28 May 2002, provides amplifying information, guidance and assistance to personnel responsible for conducting VV&A.

Solis, William M. (2005, August). ***Munitions Requirements And Combatant Commander's Needs Still Require Linkage.*** **[Letter to Secretary of Defense, Donald H. Rumsfeld]. U.S. Government Accountability Office.**

A follow-up to the GAO's original audit of DoDI 3000.4 and the MRP, this letter examined changes to the DoDI 3000.4 implemented in the October 2003 updated instruction, as well as the draft version started in 2004 which was never staffed and signed. It indicated that inadequate linkage continued to exist between the DoD, Components, and COCOMs. It stated the DIA did not coordinate with COCOMs when developing TRs, the TRs were delivered late, only the Air Force coordinated with USFK prior to modeling munitions requirements, and none of the services coordinated with USFK on the results of their individual modeling processes prior to development of POM submissions. Thus, there were no assurances that combatant commander munitions needs were met.

Training and Education Command. (2007a, September). ***GAR study process discrepancies (draft).*** **[Word document].**

This document provides a list of initial thoughts on potential discrepancies in the current methodology for determining training ammunition requirements. The list is broken into broad categories, including general comments, notes pertaining to the GTARG, TAMIS-R, as well as allocation, expenditures and redistribution of ammunition. The discrepancies listed provided guidance during the development of TECOMO 8011.1 and the TECOM study effort to evaluate the ground training ammunition requirements determination process. Section 5.2.4.1 summarizes the list of discrepancies noted in this document. (NOTE: The GAR Study Process performed by TECOM is not related to the GAR Study Team that developed this report.)

Training and Education Command. (2007b, September). ***TECOMO 8011.1 - Ground Training Ammunition Requirements Determination Process.***

This order defines the roles and responsibilities of TECOM and other Marine organizations in development of the total training ammunition requirement. See

section 4.2.4.1 for a detailed description of this document.

Training and Education Command. (2007, November). ***FY05-FY07 training expenditure spreadsheet.*** **[Excel spreadsheet].**

This spreadsheet provided Marine Corps-wide authorized allowances and actual expenditures, by DODIC, for training munitions. This data provided the basis for the historical comparison of allowances and expenditures presented in section 7.2.4.1.

United States Code. (Reflects the laws passed by Congress as of 2007, January 3). ***Title 10 – Subtitle A – Part III – Chapter 101 – Section 2010. Participation of developing countries in combined exercises: payment of incremental expenses.*** **(Downloaded from http://www.law.cornell.edu/uscode/HowCurrent.php/?tn=10&fragid=T10F01155&extid=usc_sec_10_00002010----000-&sourcedate=2008-04-28&proctime=Tue%20Apr%2029%2004:28:31%202008 on 16 June 2008).**

Complete text of Section 2010 of the US Code is as follows:

(a) The Secretary of Defense, after consultation with the Secretary of State, may pay the incremental expenses of a developing country that are incurred by that country as the direct result of participation in a bilateral or multilateral military exercise if—

(1) the exercise is undertaken primarily to enhance the security interests of the United States; and

(2) the Secretary of Defense determines that the participation by such country is necessary to the achievement of the fundamental objectives of the exercise and that those objectives cannot be achieved unless the United States provides the incremental expenses incurred by such country.

(b) The Secretary of Defense shall submit to Congress a report each year, not later than March 1, containing—

(1) a list of the developing countries for which expenses have been paid by the United States under this section during the preceding year; and

(2) the amounts expended on behalf of each government.

(c) The Secretary of Defense shall establish by regulation such accounting procedures as may be necessary to ensure that funds expended under this section are properly expended.

(d) In this section, the term "incremental expenses" means the reasonable and proper cost of the goods and services that are consumed by a developing country as a direct result of that country's participation in a bilateral or multilateral military exercise with the United States, including rations, fuel, **training ammunition**, and transportation. Such term does not include pay, allowances, and other normal costs of such country's personnel.

United States Marine Corps. (1997, February). ***MCO 8000.7 - Marine Corps Capabilities-Based Munitions Requirements (MCCBMR) Process for Ground Ammunition (Class V(W)).***

This order defines the roles and responsibilities for organizations within the USMC required to develop the ground ammunition munitions requirements. It predates the DoDI 3000.4 guidance by over six years, thus guidance that is contradictory or no longer valid exists in this document. See section 3.4 for a detailed description of this document.

United States Marine Corps. (No date). ***MCO 8000.8 (Draft) - The Marine Corps Munitions Requirements Process (MCMRP).***

Over the past few years, the Marine Corps recognized that the 1997 MCO 8000.7 was no longer consistent with the newer DoDI 3000.4 and understood that the methodology it actually used to determine munitions requirements no longer followed MCO 8000.7. Consequently, MCCDC set about writing a new order to replace MCO 8000.7.

The draft order preserved the 12-step process found in MCO 8000.7 but updated the terminology and organizational responsibilities to coincide with the guidance provided in DoDI 3000.4 and changes in the organizational structure within the Marine Corps. The draft order did, however, attempt to provide more precise descriptions of the roles and responsibilities for each organization and provide timelines for each organization's deliverables in support of the munitions requirements determination process. In addition, it proposed that a charter be created for the ESCA and AWG. The intent was to describe, in detail, the organizations that would be represented in each of these organizations, define the specific policy guidance each of these organizations was to contribute to the munitions requirements determination process, and identify and explain the additional roles and responsibilities of these organizations. As noted earlier, this draft was never completed and the charters were never written.

Wood, John. (2007, October). ***Marine Corps War Reserve Munitions Requirement (WRMR) Model, version 2.3, verification & validation (V&V) report.*** **Marine Corps Combat Development Command, Operations Analysis Division.**

This report documented the findings of the WRMR Model V&V Study Team. The report recommended model accreditation for POM-10 analysis, although it suggested an alternative methodology be used to calculate non-targeted munitions expenditures, in particular smoke and illumination expenditures. It suggests that the WRMR model output should be analyzed for accuracy and provides suggestions regarding DODIC selection for this process as it would be unfeasible to perform analysis on all 350+ DODICs. Finally, it recommended that a complete review of the Marine Corps MRP be performed.

Appendix D. Recommended Action Items

Over-Arching Process Recommendations

Recommendation: Formalize and document the USMC MRP process through the publication of an updated MCO 8000.7.

Discussion: The current MCO 8000.7 is obsolete and provides some guidance that contradicts that stated in the 2003 DoDI 3000.4 and evolving revisions of this DoD instruction. An updated order should clearly define the components of the TMR, identify the tasks necessary to develop and sustain a transparent, traceable, repeatable, and analytically sound process for generating the estimates, and assign roles and responsibilities to Marine Corps organizations capable of performing these tasks. Many of the following recommendations indicate organizational roles and responsibilities that should be incorporated into an updated MCO 8000.7.

MCCDC Decision:

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Recommendation: Organize study data, executables, results and analysis on a classified web site.

Discussion: Centralized archiving and maintenance of all information pertaining to the development of the TMR will provide much-needed traceability to USMC MRP. The archive will facilitate access by MRP participants to a well-organized, comprehensive list of instructions, information, current products and historical results. This will also allow MRP participants to readily obtain data, documents and analysis in support of their particular roles and responsibilities. It will also provide a medium to facilitate a periodic review and validation of all WRMR model data and support trends analysis. As a central repository of TMR-related information and products it will smooth the transition between MCCDC AROs responsible for the MRP.

MCCDC Decision:

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Recommendation: Utilize MCATS, or a similar tracking system, for all MRP-related inter-organizational data and support requests.

Discussion: The USMC MRP is a complex effort with numerous geographically dispersed participants, inter-related products with multiple data dependencies and a long timeframe for execution. Use of a formal tracking system will improve the traceability of requests over that available from informal systems such as e-mail or oral requests for data or support.

MCCDC Decision:

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Recommendation: Assign a senior-level oversight body, such as the CDIB, to review and validate input data and assumptions that drive the MRP process as well as review and assess the generated TMR prior to submission.

Discussion: A senior-level oversight body should ensure that the assumptions and data being used to generate the TMR are valid, free of internal contradictions and inconsistencies and based on the most current information available. This would mitigate the risk of potential "false starts" and "do-overs" in the development of the TMR. Up-front oversight of the process, combined with periodic review of supporting data by qualified USMC organizations and use of a verified, validated and accredited model, will enable the USMC to produce TMR estimates that are analytically defendable and as accurate as possible.

MCCDC Decision:

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Recommendation: Establish a civilian support function to help the MCCDC ARO perform the extensive range of tasks necessary to manage and execute the MRP.

Discussion: Unlike the US Army and Navy, the Marine Corps does not employ dedicated civilian personnel in long-term positions to support the MCCDC ARO in the MRP. With military personnel transitioning frequently, it is difficult for the Marine Corps MRP to realize the benefits that come from having personnel whose tenure is lengthy enough to provide continuity in the process across multiple MRP cycles, maintain the institutional knowledge that promotes consistency and coherence in the products, and sustain process improvements whose implementation will span several years.

MCCDC Decision:

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USMC MRP Phase I – Data Collection Process Recommendations

Recommendation: Ensure proper review of all DoD-generated data that supports the USMC MRP by actively participating in DoD MRP Working Group meetings and institutionalizing USMC organizational roles and responsibilities in an updated MCO 8000.7.

Discussion: MCCDC should actively participate in all DoD MRP Working Group meetings to ensure full understanding of outstanding issues associated with DoD-generated data. In addition, MCCDC should coordinate with relevant Marine Corps organizations to promote completeness and validity of all DoD-generated data, including the Implementation Guidance, near- and out-year Threat Reports, and the near- and out-year PTDs. The organizational roles and responsibilities of each of these agencies should be incorporated into the updated MCO 8000.7.

MCCDC Decision:

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Recommendation: Identify senior-level MCCDC personnel to participate in DoD data development working groups or steering committees and influence DoD data development issues to improve the execution of USMC MRP and enhance the quality of the TMR.

Discussion: Recent proposed versions of DoDI 3000.4 have placed an increased emphasis on the use of the Analytic Agenda to support the MRP. The GAR Study Team has noted that many of the products comprising the Analytic Agenda, including the Analytical Baselines, are inconsistent in content and quality, making their use as a starting point in analysis difficult. These inconsistencies are the products of requirements that are vaguely defined by the governing body, the Joint Analytic Data Management Steering Committee in this instance. Senior-level MCCDC personnel often represent the Marine Corps on these working groups and steering committees. Identifying and leveraging the influence of these personnel likely provides the best opportunity for MCCDC to address issues regarding DoD data that influences the MRP.

MCCDC Decision:

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Recommendation: Assign specific Marine Corps organizations the responsibility of maintaining and periodically updating relevant data components used to determine the TMR. Review and validate all data within the WRMR model.

Discussion: The WRMR model source code has been verified and validated. A comprehensive and coherent review and validation of the model input data has yet to be accomplished. MCCDC should identify qualified organizations within the USMC and assign these organizations the responsibility of reviewing and updating model data within their realm of expertise. This review should be performed periodically to ensure the data remains current, and the tasking of the specificUSMC organizations should be incorporated into the updated MCO 8000.7.

MCCDC Decision:

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Recommendation: Identify qualified MCCDC personnel and task them to actively participate in JTCG/ME Working Group meetings to ensure JMEM data for missing critical target-shooter pairings is developed.

Discussion: The JTCG/ME Working Group meetings are used to identify target-shooter pairings needed by JMEM users but not currently defined in the JMEM database. Currently, MCCDC LID provides a list of needed target-shooter pairings via e-mail to the JTCG/ME Working Group. Active, physical participation in the JTCG/ME Working Group meetings would allow MCCDC to more aggressively pursue the inclusion of their missing target-shooter pairs in future versions of JMEM, and understand the reasons why any target-shooter pairs are not included.

MCCDC Decision:

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Recommendation: Review JWES algorithm used to calculate expenditures per kill to determine validity of using these values directly in the WRMR model.

Discussion: JWES currently calculates an expenditures-per-kill value for shooter-target pairings. The algorithm is described in documentation that is provided separately from the JWES model. This algorithm should be reviewed for validity. If it is deemed valid, the methodology used to transfer JWES output data to WRMR model input data should be modified to use these values instead of the current conversion methodology.

MCCDC Decision:

_____ Approved _____ Date Implemented

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Recommendation: In compliance with DoDI 3000.4, review target templates used for indirect-fire attrition calculations with COCOM representatives.

Discussion: All versions of DoDI 3000.4 indicate that target templates used in Service modeling should be developed in coordination with the COCOMs. The target templates used for indirect-fire attrition in the WRMR model are derived from the original MCARMS database and require a periodic review to ensure currency and accuracy.

MCCDC Decision:

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Recommendation: Formalize the use of MARFORs expertise in developing the WRMR model OPLAN alignment.

Discussion: The current process of using the MARFORs to help develop the WRMR model OPLAN alignment should continue, but should be institutionalized. The request for support should be issued through an MCATS tasker, and the organizational responsibilities identified in the updated MCO 8000.7.

MCCDC Decision:

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Recommendation: Coordinate OPLAN alignments with COCOMs.

Discussion: All versions of the DoDI 3000.4 indicate that modeling assumptions and timing must be coordinated with the COCOMs.

MCCDC Decision:

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Recommendation: Formalize the methods and assumptions used to calculate CO/FP and SR capabilities.

Discussion: CO/FP and SR capabilities consist of two components: forces and the days of assault and/or sustained rates of fire required by these forces to conduct the associated operations. Recent revisions of DoDI 3000.4 have proposed different organizations be responsible for defining the forces. Thus, MCCDC will have to track this issue in future proposed revisions of DoDI 3000.4 to ensure the sources for CO/FP and SR definitions are compliant. MCCDC, in coordination with PP&O, will have to review any force structures determined by other DoD organizations to ensure the Marine Corps is adequately represented. If future versions of DoDI 3000.4 do not identify an organization to develop the CO/FP and SR forces, MCCDC must be prepared to coordinate with PP&O to do so. The methods used to determine these forces should be clearly defined in a manner that minimizes the risk of double-counting between these requirements and the CR and TTR. MCCDC should institutionalize this requirement with all roles and responsibilities captured in the updated MCO 8000.7.

MCCDC Decision:

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USMC MRP Phase II – Development of TMR Recommendations

Recommendation: Modify the WRMR model to incorporate a switch allowing the user to select whether repair and return of attrited targets is portrayed in the model.

Discussion: The COCOMs and J-8 currently account for repair and return of attrited targets when developing the near-year and out-year PTDs. This, however, may not always be the case in the future. Allowing the WRMR model analyst the flexibility to switch between these two behaviors would reduce the efforts associated with maintaining two executables or two databases.

MCCDC Decision:

_____ Approved _____ Date Implemented

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Recommendation: Modify the current algorithm used by the WRMR model to distribute targets across the battle phases to account for OPLAN alignment.

Discussion: The WRMR model currently apportions a user-defined percentage of targets to a high-intensity period of a given phase. This high-intensity period could be at the beginning or end of the phase. Marine Corps forces may experience more than one period of high-intensity combat within a given Phase of operations. Thus, modifying the algorithm used to distribute targets throughout the phase to align with the battle phases now allowed in the WRMR model would provide a more accurate depiction of Marine Corps operations in a given OPLAN.

MCCDC Decision:

_____ Approved _____ Date Implemented

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Recommendation: Develop a new methodology in the WRMR model to calculate smoke and illumination expenditures.

Discussion: The WRMR V&V Study Team and the GAR Study Team assessed as deficient the algorithm used to determine smoke and illumination expenditures in the WRMR model. Historical expenditure rates of these munitions relative to the AP/AM munitions fired by a given weapon system were used to develop the POM-10 TMR, but should be considered only an interim solution. A new algorithm should be developed to better able to account for force flow and weapons mixes than the current algorithm, and allow the ability to account for changes in TTPs and technology that an expenditure rate based on historical analysis does not.

MCCDC Decision:

_____ Approved _____ Date Implemented

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Recommendation: Develop a new methodology in the WRMR model to calculate rear-area security expenditures.

Discussion: The current rear-area security expenditure algorithm uses a rounds-per-weapon-per-day value that is difficult to determine. Implementing a new algorithm that expresses expenditures as a function of a number of engagements per day and an expenditure per engagement would more accurately reflect rear-area expenditures as experienced in the real world and reduce the possibility of double-counting expenditures with target-oriented or self-defense expenditures.

MCCDC Decision:

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Recommendation: Add error-checking to ensure that weapon systems defined in the self-defense portion of the WRMR model are not also defined in the rear-area security or target-oriented portions of the model.

Discussion: This error-checking would ensure that double-counting of expenditures can not occur between the self-defense portion of the model and the rear-area security or target-oriented portions of the model.

MCCDC Decision:

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Recommendation: Remove the variable in the WRMR model representing the frequency of required operational checks and place the value in a user-modifiable data file.

Discussion: This would alleviate the need to recompile the model in order to change this value.

MCCDC Decision:

_____ Approved _____ Date Implemented

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Recommendation: Provide TAMIS-R the ability to track inventory.

Discussion: Incorporating the ability for TAMIS-R to track inventory would allow the Marine Corps to determine the frequency and extent to which insufficient inventory prevents units from completing their training requirements.

MCCDC Decision:

_____ Approved _____ Date Implemented

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Recommendation: Require MARFORs to submit Title 10 Requirements associated with supplying allied nations ammunition to support combined training exercises to TECOM for their inclusion in the TTR.

Discussion: TECOM is responsible for generating the TTR and should maintain an overview of all requirements associated with training that are represented in the TMR. The MARFORs, therefore, should provide exercise-related Title 10 training requirements to TECOM for inclusion in the TTR as opposed to the current process of providing them to MCCDC for inclusion in the TMR. The associated organizational responsibilities for both the MARFORs and TECOM should be clearly identified in the updated MCO 8000.7.

MCCDC Decision:

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Recommendation: Task MARCORSYSCOM to explain, in writing, the justification for including the Peacetime Pipeline (PPL) requirement in the TMR or AAO, and to provide clear and consistent definitions of the PPL, TMR, and AAO and their relationship to one another.

Discussion: The PPL, TMR, and AAO, as well as their relationship to one another, are defined in an inconsistent and often contradictory manner in Marine Corps orders and memoranda. A new MCO should be developed which clearly identifies the need for the PPL, and provides a clear, consistent definition for each of these items, and their relationship to one another.

MCCDC Decision:

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Recommendation: Task MARCORSYSCOM to develop a PPL value that is unique for each DODIC.

Discussion: The current PPL is defined as the "weighted average time required to deliver ammunition to Marine forces in support of training requirements" and is set at 313 days based on analysis performed during the 1990s. It is unclear what effect new manufacturing techniques, changes to geographical storage locations and unit basing, and new ammunition types have had on this weighted average. Given the large variance by DODIC in rounds procured and times to produce and deliver these rounds, a weighted average is not the best method for determining the PPL. To improve the accuracy associated with the PPL, a unique value should be calculated for each DODIC.

This may be a contentious point as it will require new analysis to determine these values. If it is decided that the historical values will be used, however, the PPL for each DODIC should already be available since these values would be required to generate a "weighted average." If the analysis and values used to determine the 313-day weighted average are no longer available, a new calculation should be required as the 313-day value is not traceable.

MCCDC Decision:

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Recommendation: Require TECOM to provide a briefing or other document detailing the methodologies, assumptions, constraints, and data used to determine the TTR.

Discussion: The MCCDC ARO is responsible for all values contained in the TMR and must, therefore, have a clear understanding of the origin and make-up of every component. This requirement should be defined in the organizational roles and responsibilities for TECOM in the updated MCO 8000.7.

MCCDC Decision:

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Phase III – Validation, Approval, and Submission of the TMR Recommendations

Recommendation: Institutionalize the validation and approval process used to support the POM-10 TMR.

Discussion: The two-step validation process used for the POM-10 TMR, which included initial analysis by OAD and review by members of the AWG, followed by validation and approval by senior-level analysts and officers, was critical in identifying and correcting a number of initial errors in the draft TMR. If the recommendation to use a senior-level board to review and validate the input assumptions to the MRP is approved, this board should be incorporated into the validation process of the resulting TMR. All organizational roles and responsibilities associated with implementing this recommendation should be incorporated into the updated MCO 8000.7.

MCCDC Decision:

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Recommendation: Evaluate changes in expenditures for every DODIC and explain discrepancies prior to submission of draft TMR for validation and approval.

Discussion: This type of "transparency" analysis is required to understand the reasons for changes in munitions expenditures and to ensure that the changes are not due to improper transfer of data to the model or invalid assumptions or methodologies.

MCCDC Decision:

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Combat Planning Factors Recommendations

Recommendation: Develop a CPF for urban / counter-insurgency operations.

Discussion: Current assault and sustained planning factors do not represent the unique weapon mixes used to support military operations on urban terrain or counter-insurgency operations. The number and duration of these types of operations have increased in recent years and are expected to continue to comprise a large portion of the overall military operations of US forces in the current construct of the Global War on Terror. Operational planners and logistics officers, therefore, require a new CPF to estimate ammunition expenditures when preparing deployment where these types or operations are anticipated.

MCCDC Decision:

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Recommendation: Incorporate the weapons used during an operation into the MUREP submitted by the given unit.

Discussion: Including the weapons used would allow for more detailed analysis to be performed and would allow for the development and tracking of real-world CPFs. These CPFs could then be compared with WRMR model results to provide an analytic methodology for determining the validity of model-generated CPFs. In addition, utilizing this type of data from OIF/OEF would be useful in developing and validating a method used to calculate an urban operations / counter-insurgency CPF.

MCCDC Decision:

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Recommendation: Establish a single source for Marine Corps personnel to obtain updated CPF data.

Discussion: Currently, Marine Corps personnel are trained to use the MCO 8010.1E, or the MAGTF Planners Reference Manual (which refers the reader to MCO 8010.1E), for CPF data. Updated WRMR model-generated CPFs have been distributed via e-mail. Identifying a single source for all CPF data would prevent planners and ammunition officers from using obsolete data and ensure all personnel use consistent data.

MCCDC Decision:

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Recommendation: Incorporate the identified single source for CPF data into the Marine Corps schools' curriculum.

Discussion: Once a single source has been identified, all Marine Corps schools which teach the use of CPFs, such as the Combat Service Support School, must update their curriculum to ensure guidance pertaining to source data is consistent.

MCCDC Decision:

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Recommendation: Commission a study to evaluate the validity of CPFs through numerical analysis.

Discussion: The GAR Study Team was not able to complete such an analysis owing to the inability to obtain weapon density data. Additionally, Marine Corps operational planners and ammunition officers referenced multiple sources of CPF data, making suspect their assertion that the CPFs used were valid. Numerical analysis will be possible if MUREPS are modified, as suggested, to include weapon density data, and a standardized source of CPFs is identified and used by all operational planners and ammunition officers.

MCCDC Decision:

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